150

A CENTURY AND A HALF OF OHIO'S MINERALS

Ohio Division Of Geological Survey Information Circular No. 24

STATE OF OHIO

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150

A CENTURY AND A HALF OF OHIO'S MINERALS

1959

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The Ohio Division of Geological Survey, Columbus, Ohio
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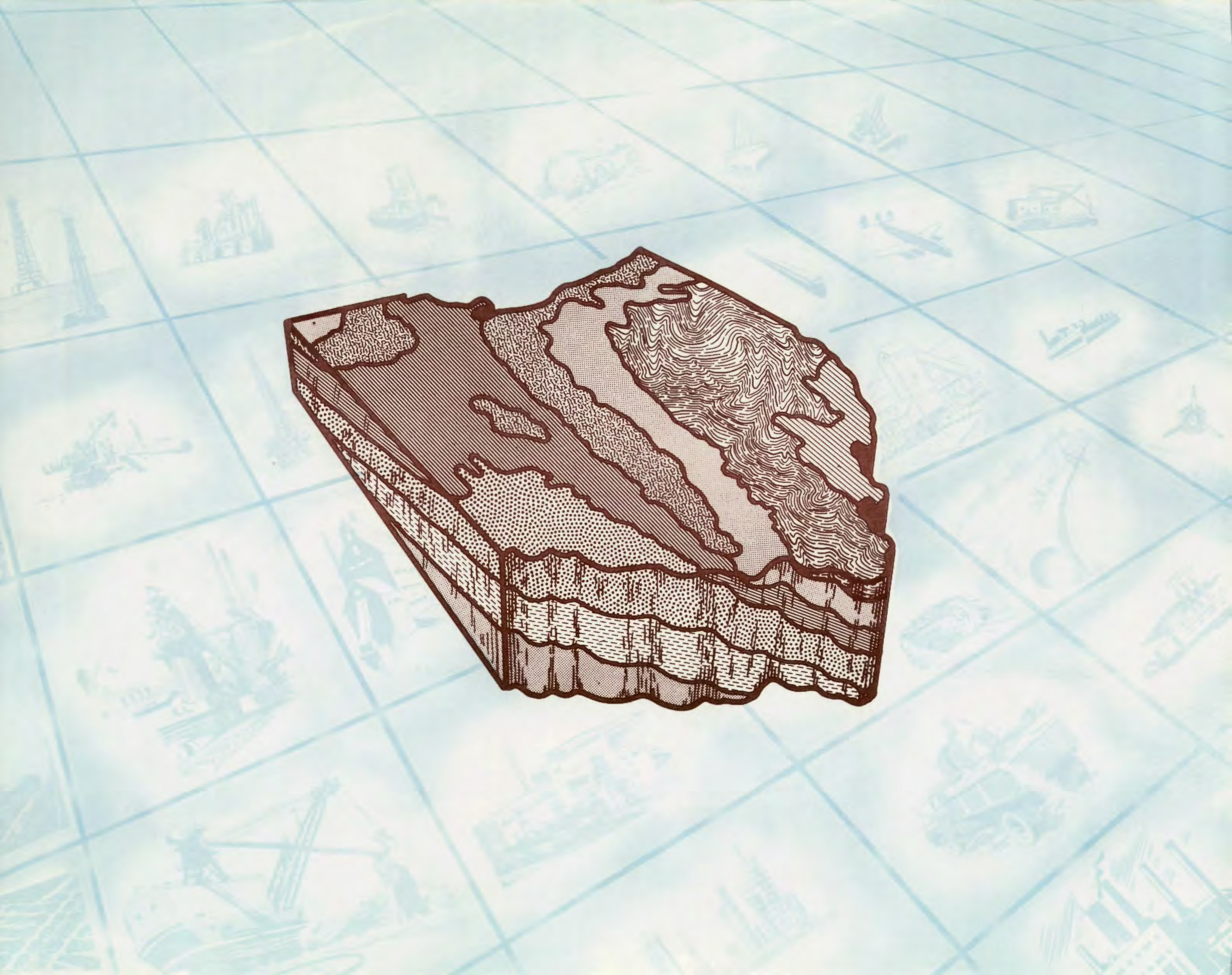


Contents....

INTRODUCTION

Since 1800 the mineral extraction industries of Ohio have removed from the state's reserves enormous tonnages of non-metallic minerals which today exceed the total value of the so-called precious minerals: gold, silver and gems of other states. Some of these extraordinary totals among the industrial minerals are: limestone and dolomite with a production of 906 million tons, sandstone with 93 million tons, clay 179 million tons, salt 92 million, sand and gravel 578 million.

Ohio's mineral fuel industry has been equally active and productive throughout the years. Coal production totals almost 2 billion tons, natural gas 3 trillion cubic feet and oil 650 million barrels. None of these figures include the inevitable losses incurred in recovery and marketing. For instance, in the case of coal, the loss is estimated at 50%, making a total of 4 billion tons mined or lost in mining since 1800. Present day losses incurred during the recovery of natural gas and oil are minor, but during the early years of their discovery and exploitation, waste was generally extensive.

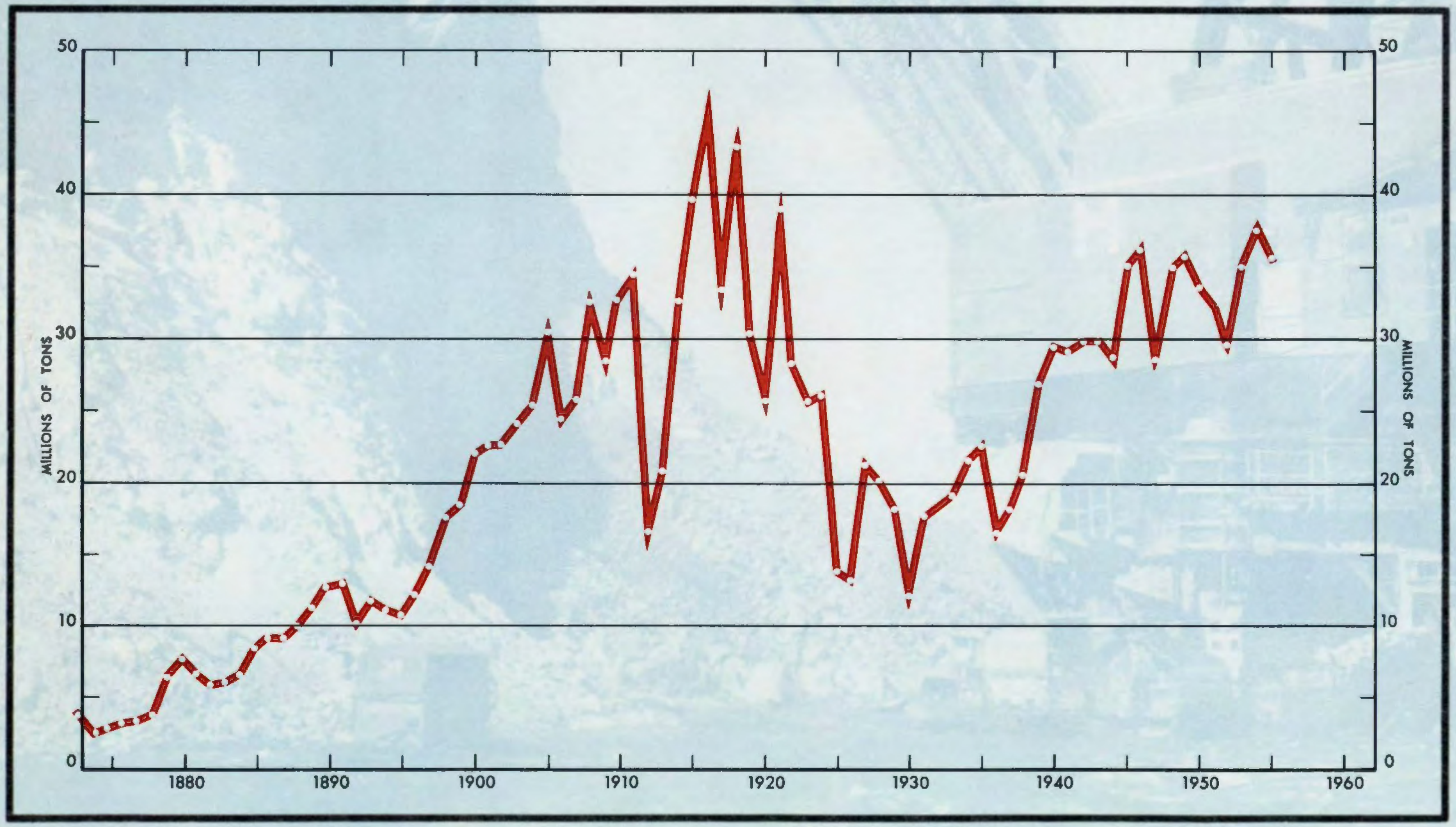
A cautious appraisal of all marketed raw mineral production, at 1957 rates, would establish a value of approximately $15 billion for the 158 years of activity reported. No attempt has been made to assess those minerals that have been subjected to manufacturing processes. Production touched upon in other mineral industry reports usually includes lime and cement manufacture, the iron and steel industry, coke, the huge Ohio ceramic industry, and many lesser manufactures, each of which could well be the subject for a separate, many-volumned report. Our only interest here is with the exceptional volume of raw minerals produced.

We have been concerned with presenting these production data in an easily readable and meaningful form and in some relation to the history and uses of each mineral discussed. In addition we have tried to indicate briefly the prime areas of occurrence, probable reserves, and diverse needs which each has met throughout the years. The short references to current or needed research will be of interest to many.

COAL

Over ten times as much recoverable coal still lies underground in Ohio as has been mined and lost in mining since 1800.

Coal PRODUCTION



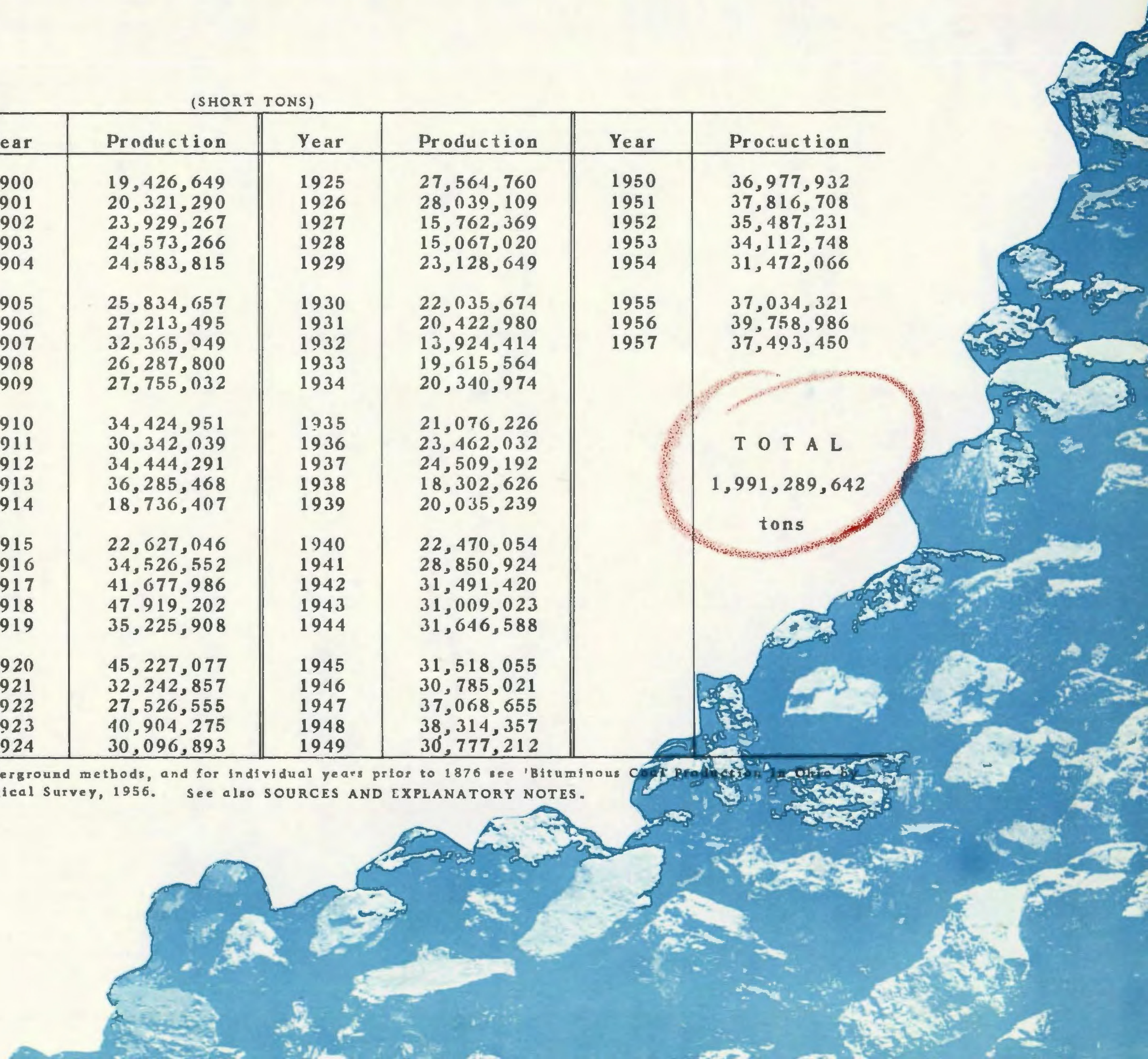
COAL

Production

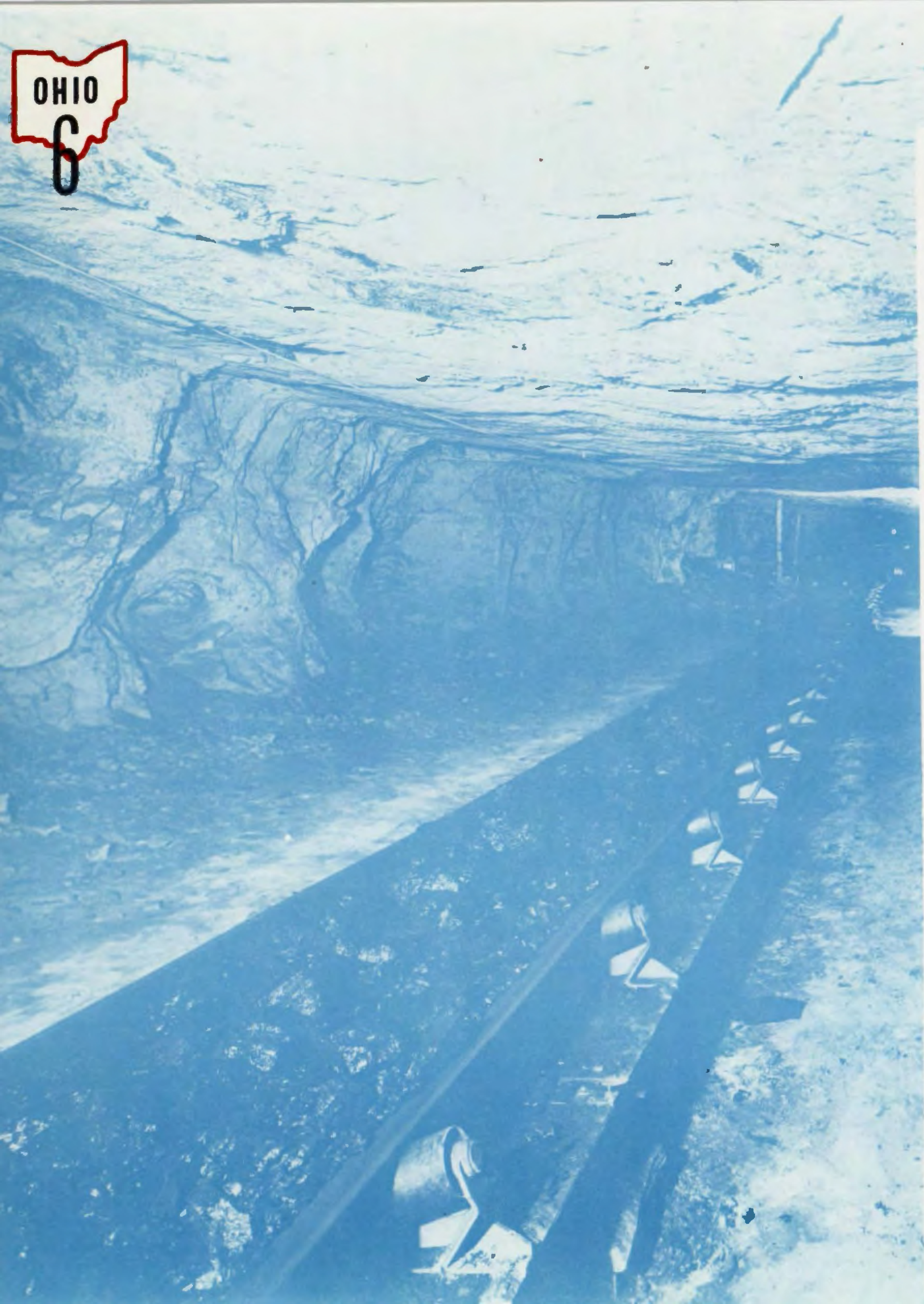
(SHORT TONS)

Year	Production	Year	Production	Year	Production	Year	Production
1800--1875	65,240,427	1900	19,426,649	1925	27,564,760	1950	36,977,932
1876	4,210,182	1901	20,321,290	1926	28,039,109	1951	37,816,708
1877	4,580,048	1902	23,929,267	1927	15,762,369	1952	35,487,231
1878	4,911,116	1903	24,573,266	1928	15,067,020	1953	34,112,748
1879	5,404,980	1904	24,583,815	1929	23,128,649	1954	31,472,066
1880	7,956,995	1905	25,834,657	1930	22,035,674	1955	37,034,321
1881	8,225,000	1906	27,213,495	1931	20,422,980	1956	39,758,986
1882	9,450,000	1907	32,365,949	1932	13,924,414	1957	37,493,450
1883	8,229,429	1908	26,287,800	1933	19,615,564		
1884	7,550,062	1909	27,755,032	1934	20,340,974		
1885	7,816,179	1910	34,424,951	1935	21,076,226		
1886	8,435,211	1911	30,342,039	1936	23,462,032		TOTAL
1887	10,301,708	1912	34,444,291	1937	24,509,192		1,991,289,642
1888	10,910,946	1913	36,285,468	1938	18,302,626		tons
1889	10,907,385	1914	18,736,407	1939	20,035,239		
1890	11,788,859	1915	22,627,046	1940	22,470,054		
1891	13,050,187	1916	34,526,552	1941	28,850,924		
1892	14,599,908	1917	41,677,986	1942	31,491,420		
1893	14,828,097	1918	47.919,202	1943	31,009,023		
1894	11,910,219	1919	35,225,908	1944	31,646,588		
1895	13,683,879	1920	45,227,077	1945	31,518,055		
1896	12,912,608	1921	32,242,857	1946	30,785,021		
1897	12,448,822	1922	27,526,555	1947	37,068,655		
1898	14,058,155	1923	40,904,275	1948	38,314,357		
1899	15,908,934	1924	30,096,893	1949	30,777,212		

For production by county, by strip or underground methods, and for individual years prior to 1876 see 'Bituminous Coal Production in Ohio by County, 1800 - 1955 , Division of Geological Survey, 1956. See also SOURCES AND EXPLANATORY NOTES.



OHIO 6



COAL MEMORANDA

Coal is defined as a black, or brownish-black, solid, combustible mineral substance formed by the partial decomposition of vegetable matter without free access of air, under the influence of moisture, pressure and temperature. Chemically it is a composition of carbon, hydrogen, nitrogen, sulphur and all the inorganic non-combustible substances which compose the ash when coal is burned. Ohio's coal ranks as high-volatile B bituminous.

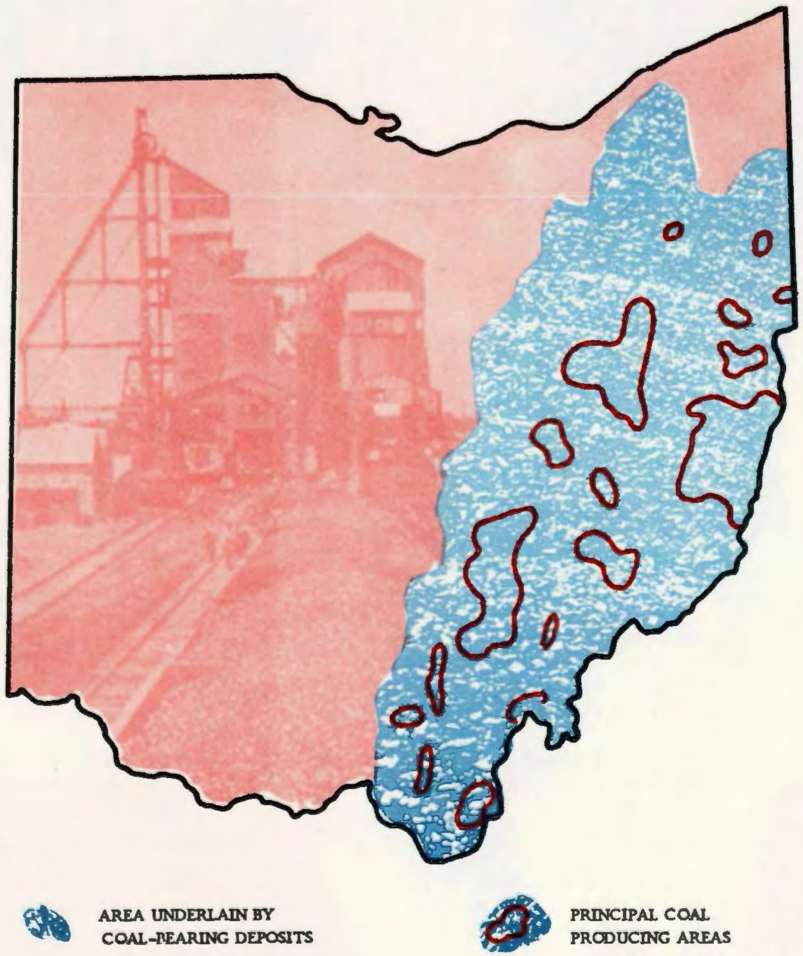
Without doubt coal is Ohio's most valuable and versatile mineral and is the foundation upon which much of the state's industry and wealth has been built. From the time of the earliest settlements to the present day, despite cultural and industrial changes, coal has played an increasingly vital role in maintaining our high standard of living.

It was first used in a small way as a source of household heat; later it provided the energy for many small industries such as the blacksmith shop and the brick kiln. It was also in considerable demand as fuel in the evaporation of brine. Shipments of coal down the Ohio and Mississippi Rivers to the sugar refineries at New Orleans was begun as early as 1835.

The presence of raw coal suitable for use in blast furnaces plus the occurrence of iron ore and limestone gave a tremendous impetus to mining in the state. Scores of furnaces were scattered throughout eastern and southeastern Ohio in the middle and late 1800's. Expansion in the coal industry was further stimulated by the canals and later by the railroads which began to crisscross Ohio. Increasing quantities of coal were also mined for heating purposes, and the arrival of World War I demanded a hitherto unbelievable effort in the production of coal. In 1918 an all-time high in output was achieved in the approximately 48 million tons recorded for that year.

From the late 1920's until World War II coal production in Ohio declined, a situation due in part to the depression, but also because of the deep inroads made by the increased use of the liquid and gaseous fuels for both industrial energy and domestic heating. Only a few short years ago, the most optimistic outlook for the Ohio coal industry was still somewhat discouraging.

Because Ohio coal continued to be most economical in the production of electricity, increasing demand for use by generating plants was responsible for a new vitality in the industry. The increased importance of coal in the chemical industries should also be noted. Such everyday items as drugs, nylon, plastics, perfume, dyes, fertilizers, provide an ever-widening horizon for the uses of coal.



The accompanying map shows in a general way how 32 Ohio counties share in the state's coal reserves. There are approximately 60 distinct seams to be found in the Pennsylvanian and Permian systems, 23 of which may be considered commercially valuable. The coal area represented here is equal to some 12,350 square miles or about one third of the state's territory.

A few years ago the Ohio Division of Geological Survey undertook a re-evaluation of the original coal reserves of the state. This study was completed only recently and indicated that, before mining operations began, an estimated 46 billion tons of recoverable coal underlay Ohio. Of this reserve 4 billion tons have been mined or lost in the mining process, leaving at present approximately 42 billion tons of reserve. Since the over-all recovery rate of mining is 50%, Ohio's remaining recoverable reserves are probably in the neighborhood of 21 billion tons. Every million tons recovered from the initial reserves, of course, increases the value of any remaining reserves.

Many of these coal deposits lie relatively near the surface in Ohio, a condition which is an encouragement to strip mining, a method of recovery currently responsible for over 60% of the annual production in this state.

Almost 64% of the original reserves are distributed within the following ten counties: Athens, Belmont, Carroll, Columbiana, Guernsey, Harrison, Jefferson, Monroe, Muskingum and Tuscarawas. About 33% of the reserves lie in Belmont, Guernsey, Jefferson and Monroe Counties. The seams which account for 72% of the reserves are: Meigs Creek, 8.6%; Pittsburgh, 11.9%; Upper Freeport, 9.0%; Middle Kittanning, 20.9%; and Lower Kittanning, 21.2%.

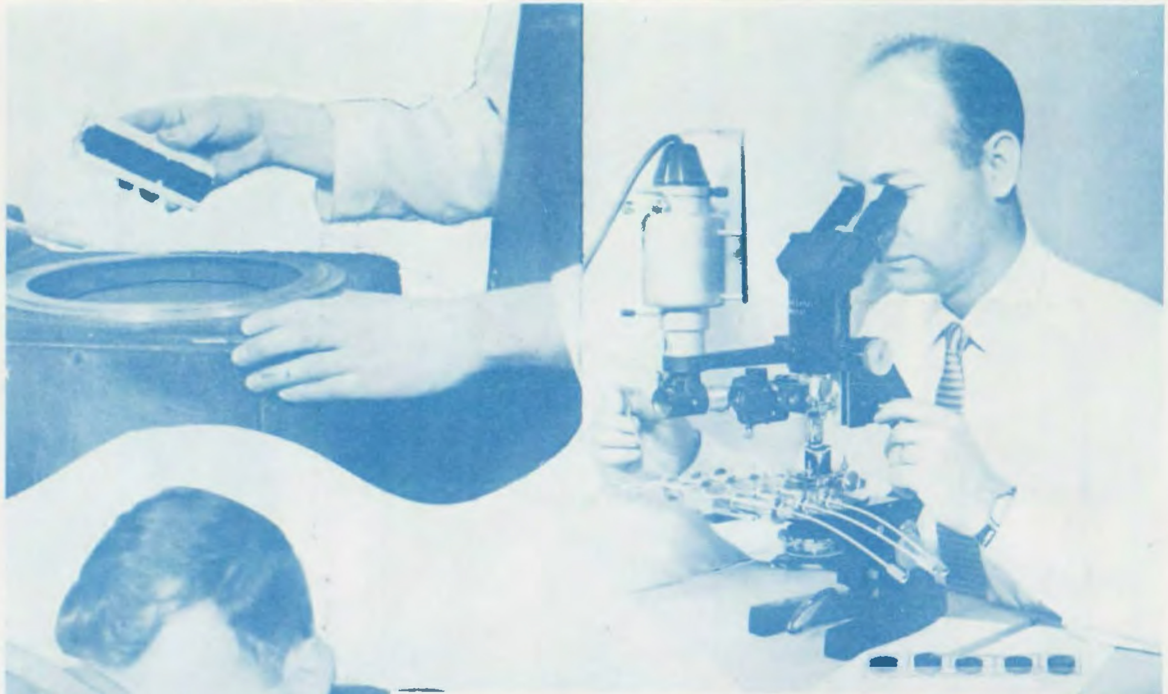
Coal
OCCURRENCES & RESERVES

Coal Research

The benefits to be derived from research in any area are generally recognized. In the case of coal and its utilization, research for years has been the tool with which this versatile deposit is fashioned into a more valuable and vital ingredient of our day-to-day lives. Today's coal research program at the Ohio Geological Survey includes both field and laboratory programs and, while limited, provides a noteworthy addition to the body of knowledge in this field and makes a substantial contribution to the coal industry.

Field mapping of coal beds to determine their extent and continuity is a basic factor in coal research and in computing reserve estimates. An intensive study, only recently completed, yields a modern interpretation of Ohio's original coal resources; a follow-up study of strip coal reserves has also been initiated.

Complete stratigraphic data on coal and associated rocks have been recorded on business machine cards. Of the 32 counties in Ohio which are underlain by coal, stratigraphic information for all or part of 21 has been punched on such cards. The use of the machines has provided the Survey with ready and accurate tabulations of coal reserve data and has aided in assembling data for further geologic investigations, including studies in variations of roof strata of each coal bed and lithologic and source area studies of associated strata.



In the laboratory the study of fossil pollen and spores, formally called palynology, is yielding information increasingly useful in dating sequences of the sedimentary rocks of Ohio, particularly the coal beds. Each coal seam has a distinctive fossil spore assemblage which has proved to be a useful feature in correlating beds throughout their areas of deposition.

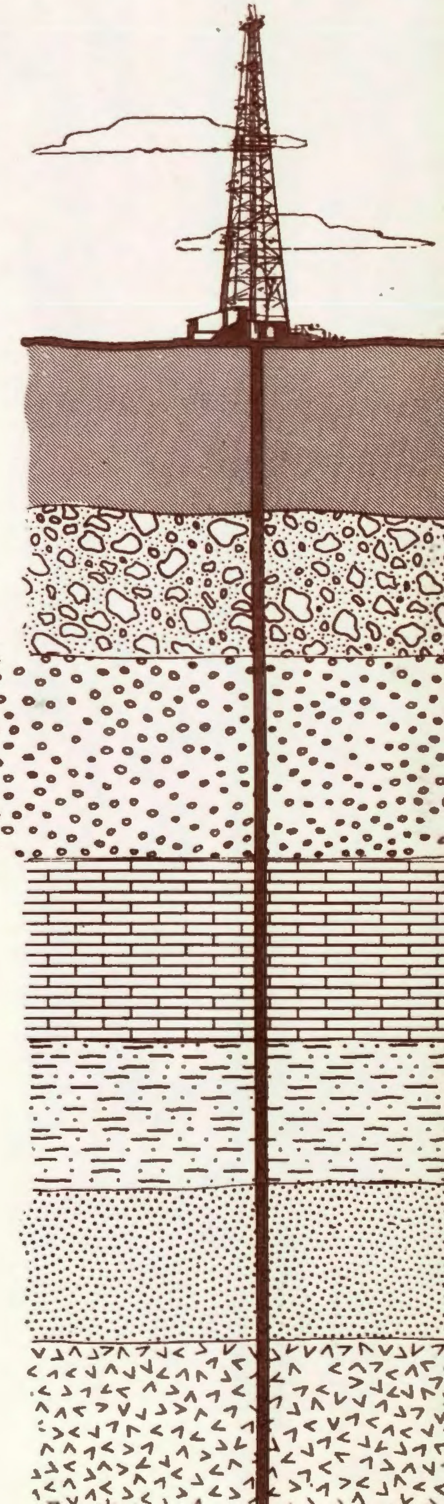
The examination of thin sections and polished surfaces of coal under the microscope is called coal petrography. This science investigates the physical properties of the coal and indicates how best to utilize it. The Ohio Geological Survey is actively engaged in this aspect of coal research, and as a result of a grant by the National Science Foundation, one coal bed study has been completed. Several other coal beds are being studied currently.

The Ohio Geological Survey, in cooperation with the Engineering Experiment Station of the Ohio State University, is continuing studies of the chemical composition of Ohio's coal. Scores of analyses are in open files or on business machine tabulations. New publications now in manuscript will assure the ready availability of these data.

The Survey will continue to emphasize its coal research program within the limits of its budget. It will gain in momentum and vitality in proportion to its resources. Its ability to maintain a continued responsiveness to new needs as they arise will mean additional, enduring contributions to Ohio's industrial and technological advancement.

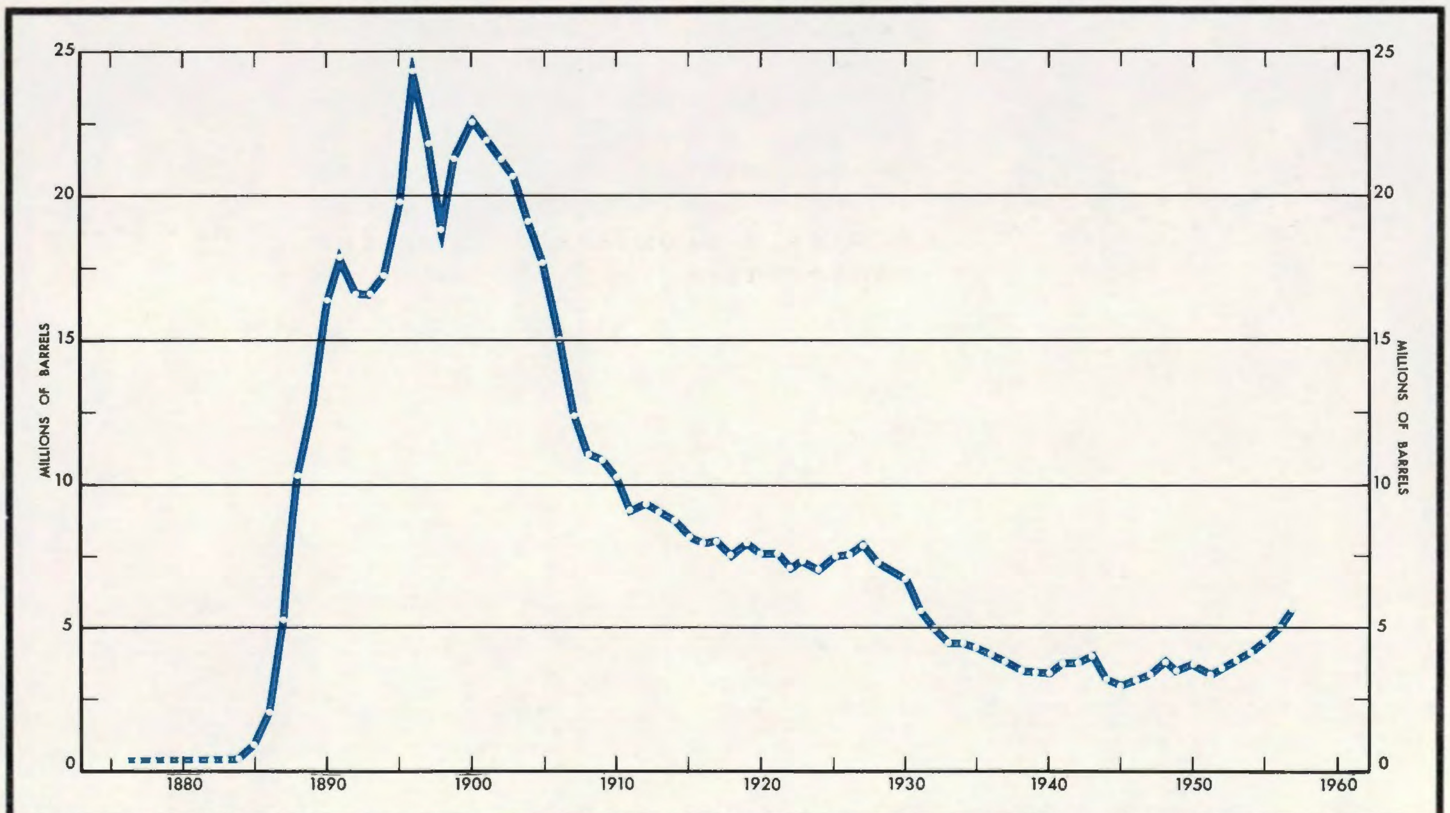
OIL and GAS

Ohio with its relatively shallow production, favorable drilling regulations, a ready market, and potential off-shore drilling in Lake Erie beckons to oil men as a promising area for exploration.



Oil

PRODUCTION



Oil PRODUCTION

(BARRELS)

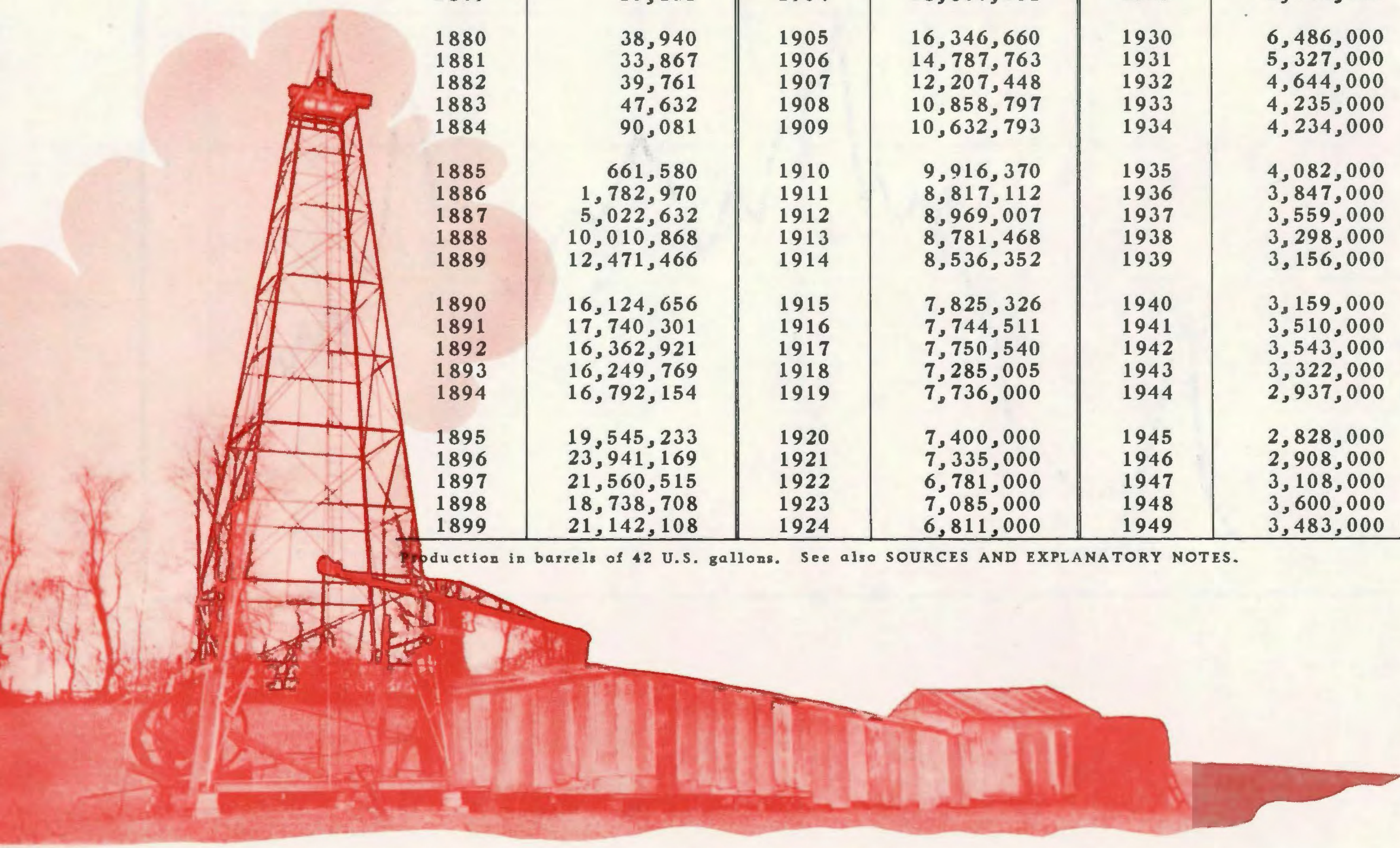
Year	Production	Year	Production	Year	Production	Year	Production
1860--1875	200,000	1900	22,362,730	1925	7,212,000	1950	3,383,000
1876	31,763	1901	21,648,083	1926	7,272,000	1951	3,140,000
1877	29,888	1902	21,014,231	1927	7,593,000	1952	3,350,000
1878	38,179	1903	20,480,286	1928	7,015,000	1953	3,610,000
1879	29,112	1904	18,876,631	1929	6,743,000	1954	3,880,000
1880	38,940	1905	16,346,660	1930	6,486,000	1955	4,353,000
1881	33,867	1906	14,787,763	1931	5,327,000	1956	4,785,000
1882	39,761	1907	12,207,448	1932	4,644,000	1957	5,478,000
1883	47,632	1908	10,858,797	1933	4,235,000		
1884	90,081	1909	10,632,793	1934	4,234,000		
1885	661,580	1910	9,916,370	1935	4,082,000		
1886	1,782,970	1911	8,817,112	1936	3,847,000		
1887	5,022,632	1912	8,969,007	1937	3,559,000		
1888	10,010,868	1913	8,781,468	1938	3,298,000		
1889	12,471,466	1914	8,536,352	1939	3,156,000		
1890	16,124,656	1915	7,825,326	1940	3,159,000		
1891	17,740,301	1916	7,744,511	1941	3,510,000		
1892	16,362,921	1917	7,750,540	1942	3,543,000		
1893	16,249,769	1918	7,285,005	1943	3,322,000		
1894	16,792,154	1919	7,736,000	1944	2,937,000		
1895	19,545,233	1920	7,400,000	1945	2,828,000		
1896	23,941,169	1921	7,335,000	1946	2,908,000		
1897	21,560,515	1922	6,781,000	1947	3,108,000		
1898	18,738,708	1923	7,085,000	1948	3,600,000		
1899	21,142,108	1924	6,811,000	1949	3,483,000		

TOTAL

649,795,386

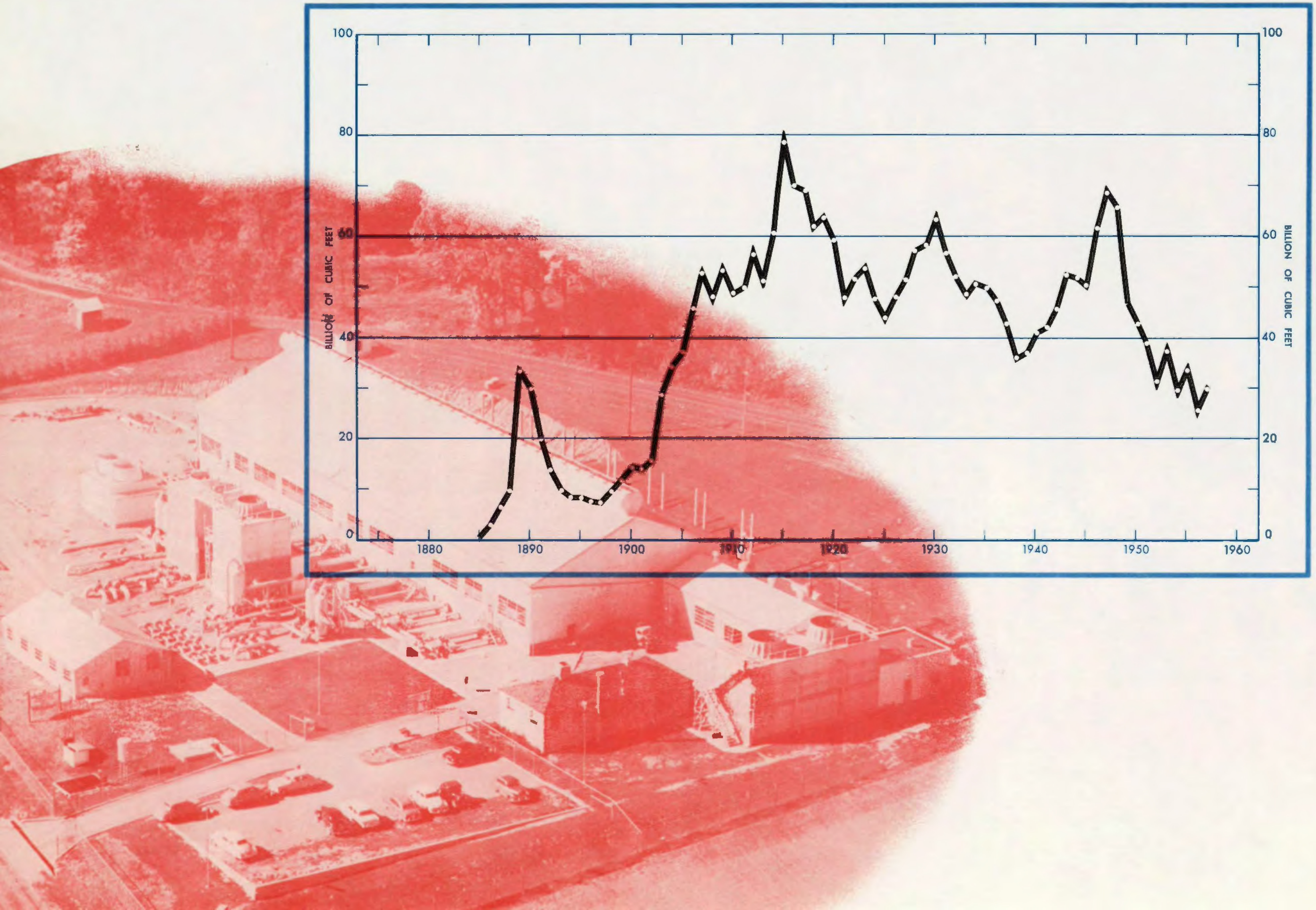
barrels

Production in barrels of 42 U.S. gallons. See also SOURCES AND EXPLANATORY NOTES.



OHIO 12

Gas production



(THOUSANDS OF CUBIC FEET)

Year	Production	Year	Production	Year	Production	Year	Production
1800--1875	-	1900	13,926,400[e]	1925	43,235,000	1950	43,163,000
1876	-	1901	13,728,000[e]	1926	47,363,000	1951	38,879,000
1877	-	1902	15,059,200[e]	1927	51,381,000	1952	30,993,000
1878	-	1903	28,636,800[e]	1928	56,341,000	1953	37,542,000
1879	-	1904	33,987,200[e]	1929	57,936,000	1954	28,824,000
1880	-	1905	36,579,200[e]	1930	63,394,000	1955	33,756,000
1881	-	1906	45,436,020	1931	56,326,000	1956	25,368,000
1882	-	1907	52,040,996	1932	51,466,000	1957	29,300,000
1883	-	1908	47,442,393	1933	47,929,000		
1884	-	1909	53,222,619	1934	50,330,000		
1885	640,000[e]	1910	48,232,406	1935	49,592,000		
1886	2,556,800[e]	1911	49,449,749	1936	46,994,000		TOTAL
1887	6,393,600[e]	1912	56,210,052	1937	42,783,000		
1888	9,590,400[e]	1913	50,612,211	1938	35,257,000		2,921,197,422
1889	33,350,400[e]	1914	68,270,174	1939	36,469,000		
1890	29,948,800[e]	1915	79,510,032	1940	40,639,000		mcf
1891	19,667,200[e]	1916	69,888,070	1941	41,858,000		
1892	13,657,600[e]	1917	68,917,231	1942	45,055,000		
1893	9,657,600[e]	1918	61,261,069	1943	52,001,000		
1894	8,160,000[e]	1919	63,153,400	1944	51,724,000		
1895	8,028,800[e]	1920	58,938,000	1945	49,967,000		
1896	7,494,400[e]	1921	47,412,000	1946	61,570,000		
1897	7,488,000[e]	1922	51,481,000	1947	68,946,000		
1898	9,516,800[e]	1923	53,812,000	1948	65,619,000		
1899	11,932,800[e]	1924	47,396,000	1949	46,512,000		

See also SOURCES AND EXPLANATORY NOTES.
e - Estimated. p - Preliminary.

GAS production

MEMORANDA

OIL

One of the first recorded oil wells in Ohio was drilled in the year 1814. Two pioneers searching for salt, a scarce commodity on the frontier, staked a location in Noble County near the village of South Olive for the purpose of drilling a well to obtain brine. These enterprising pioneers had drilled to a depth of 475 feet when they struck oil, a product which had little interest for them.

About 1859, however, the early oil boomers spilled out of Pennsylvania into West Virginia and Ohio seeking the once scorned petroleum. Production from the Berea sandstone came into its own with the discovery of the Mecca pool in Trumbull County in 1860. This pool is estimated to have had 2,000 to 2,500 wells, each about 50 feet deep.

During the 1880's many small fields and some large ones, such as the Lima-Indiana field, were discovered. Wells flowed as much as 10,000 barrels a day from a producing zone only 1,200 feet deep. In ten years after its discovery the Ohio portion of the field produced 20 million barrels of oil.

Ohio reached its peak in 1896 when approximately 24 million barrels of oil were produced. Following that year there was a gradual decline until 1945 when only 2.8 million barrels were produced. Since 1945 there has been a slight upward trend, and in 1957 about 5.5 million barrels were recovered. The general decline following 1896, along with the subsequent discoveries in the southwestern states relegated Ohio to 19th position among producing states in 1956.

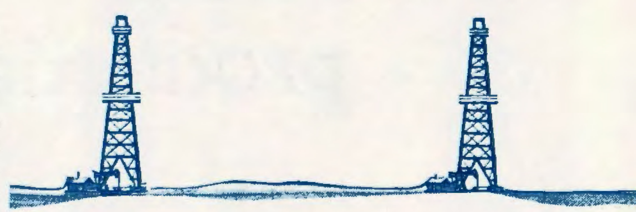
GAS

Natural gas may be defined as gaseous hydrocarbon compounds originating within the earth, probably of organic origin, and usually associated more or less closely with petroleum. This term is applied to gases that are entrapped in interstices in the zone of saturation; i.e., prevented from escape to or communication with the atmosphere by an over-lying, effectively impermeable bed. A body of natural gas is generally under hydrostatic pressure transmitted by water from below.

The first recorded gas well in Ohio was drilled near the town of Findlay in 1836. Again another substance was being sought when gas was encountered. In this instance water was the desired product. About two years later another well was dug in the town of Findlay. This well produced a considerable volume of gas and gave impetus to exploration in that area.

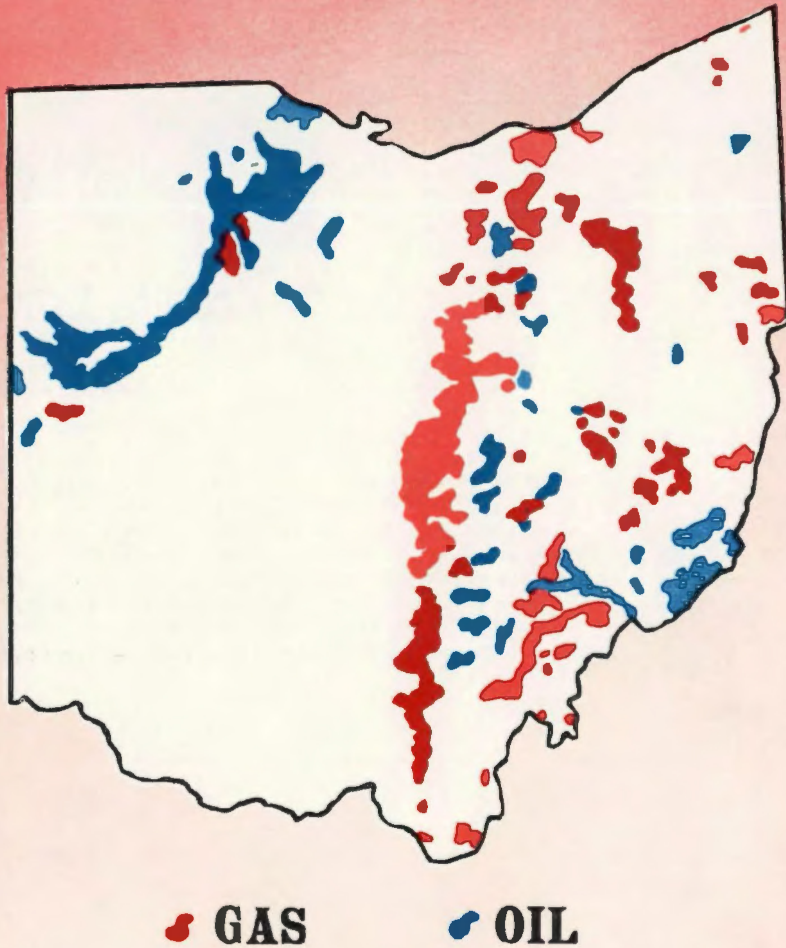
A few years later, when its economic value was recognized by industry, gas was sought with great activity and persistence. Its value as fuel for heat, light and industrial power influenced the demand for this new and abundant natural resource. Industries soon began to move into areas boasting a large supply of the new fuel. The adaptation of natural gas to the manufacture of glass was a forerunner of many others; industries producing iron, furniture, lime and bricks soon followed. The use of gas continued at an ever-increasing rate until today natural gas from Ohio fields as well as gas transmitted from other states supplies approximately 23.5% of our total energy requirements.

The extent and intensity of exploration for oil and gas in any given area is determined by a host of factors ranging from local drilling regulations to world market trends, factors which in their final analysis are economic. The profit motive prevails in this industry as in any other. At present Ohio is witnessing a renewed interest in oil and gas exploration. How long this interest will persist is unpredictable, but it appears that wildcat drilling will be undertaken both in proven areas and to unexplored horizons at greater depths.



OIL AND GAS

OCCURRENCES & RESERVES



Some oil and/or gas has been withdrawn at one time or another from wells within the boundaries of 56 of Ohio's 88 counties. These producing fields comprise some 550,000 acres or only a little over 2% of the state's total area. An additional, nonproductive, estimated acreage under lease as of January 1, 1958, increased the total possibly productive area under consideration at this time to approximately 12% of the state's total area.

By the end of 1957 there were 17,098 producing oil wells and 6,970 producing gas wells in the state. The total value of crude oil, natural gas liquids and natural gas produced in 1957 was $25,675,000. This figure represented 5.9% of the total value of all minerals produced. There were 3,700 employees actively engaged in crude oil and natural gas production.

Total footage drilled during 1957 was 2,374,969 feet, an average of 2,281 feet per well drilled. During this year only one new oil field was found; no new gas fields were located. New crude oil reserves located, however, totaled 10,128,000 barrels. In addition new natural gas liquid reserves discovered reached 160,000 barrels. A total of 58,750 million cubic feet of new natural gas reserves were located.

As of January 1, 1958 there were 68,150,000 barrels of proven crude oil reserves, 1,810,000 barrels of proven natural gas liquid reserves, and 901,814 million cubic feet of proven natural gas reserves.

OIL and GAS RESEARCH

Because oil and gas have a common origin and very frequently occur together, the research program of the Ohio Geological Survey is a combined effort directed toward the discovery and development of both fuels.

Well cuttings and cores are necessary prerequisites in a research program involving subsurface geology. In cooperation with the operators and well drillers sets of cuttings have been accumulated from several hundred wells in the state. Samples of rock cuttings are taken at five foot intervals, examined closely under the binocular microscope and carefully logged. In addition to a written description of the lithology, a graphic representation is made and posted on a strip log. Such strip logs are valuable tools in correlating subsurface stratigraphic units throughout the state. By noting character changes in the various lithologic units over a wide area and posting such data on maps it is possible to deduce the environment in which the material was originally deposited and to forecast conditions under which a given rock unit may be productive of oil or gas.

The Ohio Geological Survey has a library of sample cuttings from wells throughout the state, and additions are constantly being made to this collection. The cuttings and their accompanying logs are available for study by geologists in government and industry.

In addition to the sample library there are also a number of cores available for inspection. Because of space limitations the number of cores that can be preserved is limited; a representative number, however, is maintained. Those judged to be most nearly complete and most characteristic of a particular formation are stored and are available for examination.

In many instances the drill penetrates a sequence of rocks from which the cuttings are sparsely fossiliferous and very similar in composition, texture and appearance. To differentiate between the various rock units in such cases the Ohio Survey has adopted a study tool long in use by the Missouri Geological Survey but relatively new in the Appalachian Basin. This method involves the application of insoluble residues to the study of cuttings, and through its use it is possible to differentiate those stratigraphic units which defy identification by conventional methods. Many sets of such insoluble residues are available at the Survey.

Files of drillers' logs for all wells drilled in the state are also amintained. A library of over 200,000 of these logs has been established and made accessible to the public. The time-consuming task of locating them on individual township property maps with a scale of 4 inches to the mile has also been undertaken. At the present time about one half of the eastern part of the state has been completed. These maps are an important step in the research program and comprise the basic groundwork for any future detailed subsurface surveys. They become the foundation for cross sections of subsurface geologic conditions, for structure maps and isopachous maps, material which is in constant demand by the oil and gas industry.

In an effort to keep up with recent advances in well surveying techniques a file of electrical logs has also been established. In addition to other types of data this file contains gamma-ray and neutron type of logs. The data acquired from these logs are invaluable in the interpretation of subsurface geologic conditions.

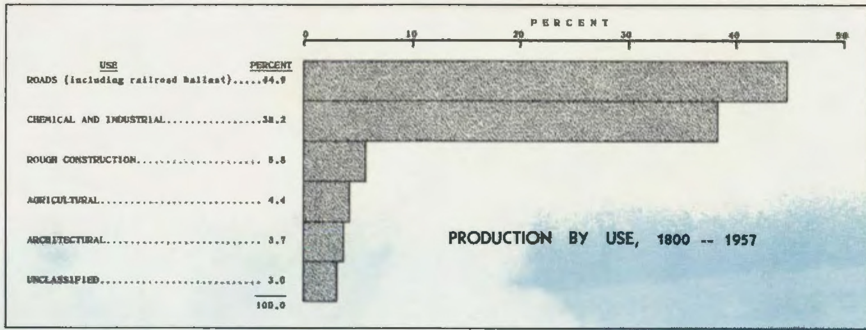
Basic research in subsurface stratigraphy needs acceleration not only in Ohio but in the entire Appalachian Basin. The regional analyses will continue under the programs of both governmental and industrial organizations. However, the detailed examination of individual pool areas has been neglected. This must be undertaken before there is an understanding of critical reservoir characteristics which govern accumulation and production of oil in our state.

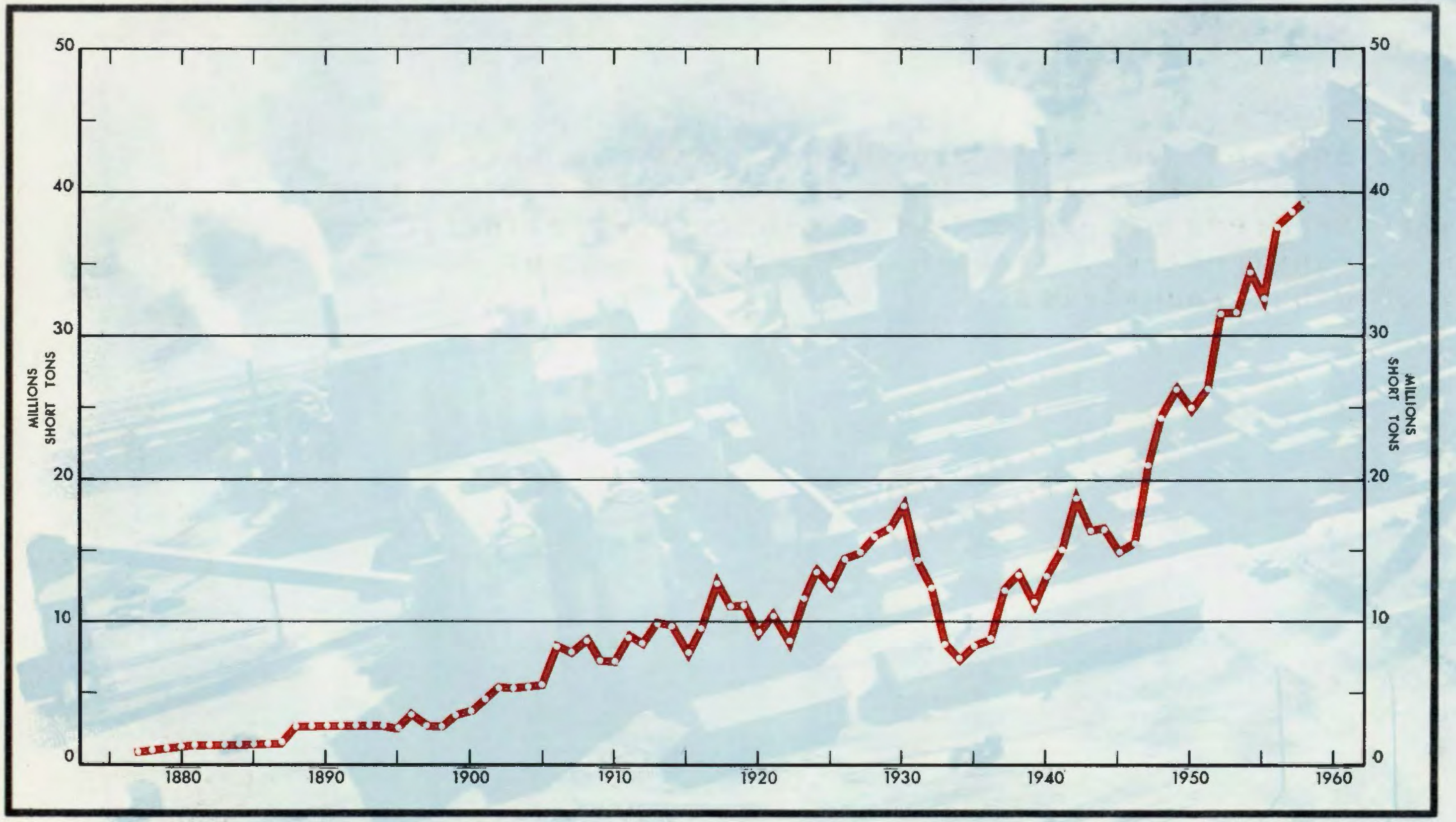
LIMESTONE & DOLOMITE

Limestone and dolomite are Ohio's most versatile industrial minerals. Both are processed into literally hundreds of products for use in agriculture, ceramics, construction, steel making, lime, cement and a host of other industries.

Production

LIMESTONE and DOLOMITE





LIMESTONE & DOLOMITE

PRODUCTION

(SHORT TONS)

Year	Production	Year	Production	Year	Production	Year	Production
1800--1875	7,500,000 e	1900	4,026,711	1925	14,001,765	1950	25,940,346
1876	500,000 e	1901	4,988,969	1926	14,400,728	1951	31,157,460
1877	600,000 e	1902	4,795,608	1927	15,663,399	1952	31,351,241
1878	700,000 e	1903	5,128,288	1928	16,317,213	1953	33,993,399
1879	800,000 e	1904	5,193,563	1929	17,815,698	1954	32,116,129
1880	904,328	1905	7,985,004	1930	13,800,315	1955	37,397,615
1881	925,000 e	1906	7,506,423	1931	10,899,803	1956	38,382,168
1882	950,000 e	1907	8,330,695	1932	7,839,139	1957	39,191,997
1883	975,000 e	1908	6,812,029	1933	6,920,913		
1884	1,000,000 e	1909	6,806,327	1934	7,999,293		
1885	1,141,375	1910	8,595,029	1935	8,327,447		
1886	1,935,481	1911	8,131,687	1936	11,884,746		
1887	2,762,858	1912	9,537,225	1937	13,092,124		
1888	3,195,416	1913	9,266,775	1938	10,871,394		
1889	2,614,480	1914 e	7,254,645 e	1939	12,811,172		
1890	2,403,667	1915 e	9,253,678 e	1940	14,822,336		
1891	2,986,209	1916 e	12,350,652 e	1941	18,521,846		
1892	2,835,723	1917	10,671,697	1942	15,920,810		
1893	2,345,248	1918	10,765,201	1943	16,185,593		
1894	1,742,574	1919	8,691,885	1944 e	14,572,408 e		
1895	3,199,327	1920	10,137,206	1945	15,029,309		
1896	2,312,674	1921	8,006,880	1946 e	20,593,176 e		
1897	2,421,714	1922	11,241,996	1947	24,184,823		
1898	3,115,834	1923	13,166,903	1948	26,089,121		
1899	3,356,794	1924	12,031,691	1949	24,481,775		

TOTAL

906,477,170

tons

See also SOURCES AND EXPLANATORY NOTES.

e - Estimated entirely or in part.

LIMESTONE & DOLOMITE

MEMORANDA

Limestone and dolomite are irreplaceable components of Ohio's industry. They are used more extensively than any other rock produced in Ohio. The annual limestone and dolomite production tonnage in recent years exceeded that of all other minerals mined in Ohio, including coal.

Rocks mined in Ohio and included in the general term 'limestone' vary in composition from that of a true limestone to that of a dolomite. A true limestone is predominantly calcium carbonate with little or no magnesium carbonate. If magnesium carbonate is present in sufficient amounts the rock is technically a dolomite.

Early settlers in Ohio found that the limestone and dolomite slabs lying in the fields and streams were useful construction materials and used them extensively in building their homes. Such stones were first used in the construction of foundations, chimneys and fireplaces; limestone with pleasing colors and textures was used in hearths, window sills and door jambs. Because stones of differing qualities were used in fireplaces, it was soon discovered that certain ones were readily disintegrated by the heat into quick lime and could be used for making mortar and plaster. Limestones containing clay were used in bonding heavy masonry in canal locks, abutments, piers, and retaining walls.

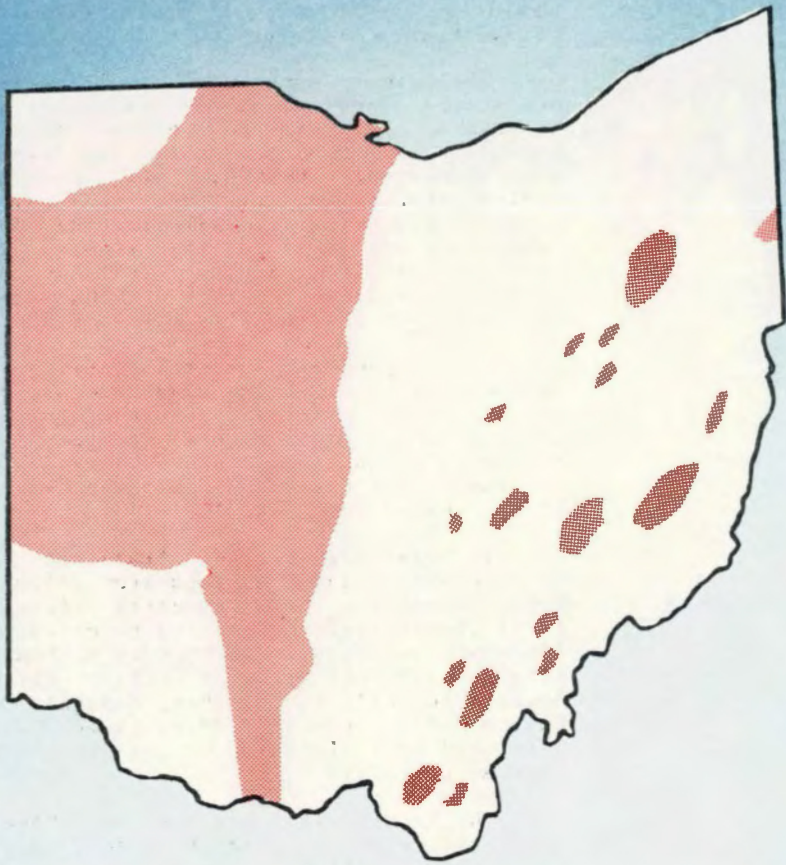
The early iron industry in Ohio used native limestones and dolomites for fluxing impurities from the ore. Some limestone was also used for refining iron in forges for the production of bar iron.

The increased demand for limestone and dolomite soon exhausted the loose stone supply from fields and streams, and men turned to quarrying the stone from its outcrop. Early quarrying operations were limited to well-bedded or laminated rocks which could be readily split into slabs. Later the more massive rocks were exploited by sawing or blasting when more powerful and improved equipment became available to the quarry operators.

Industrial expansion of the state continues to make ever-increasing demands upon the limestone and dolomite resources for utilization in the manufacturing and construction industries. Today Ohio's limestone and dolomite are used in innumerable ways. The more important uses in decreasing order of tons consumed are concrete aggregate and road metal, fluxstone, cement manufacture, lime manufacture and agricultural dust. Some of the present minor uses and possible future important uses for Ohio's high-calcium limestones are for alkali manufacture, sugar refining, paper manufacture, poultry and animal meal, rock dusting, mineral whiting, stucco and terrazzo, and glass manufacture.

For many years Ohio has led all other states in the production of lime. Its preeminent position among lime producing states is due to its production of high-magnesium lime used in the building and metallurgical industries.

Future consumption of the many products of Ohio's limestone and dolomites will continue to grow in response to the needs of a swelling population. In addition to this increased demand for today's products it is felt that research will discover new uses for Ohio's stone. Also, her underground resources of limestone and dolomite are virtually unexplored, and investigation may reveal deposits of better quality than we now know of on the surface. Discovery of a better quality stone, particularly a high-calcium limestone, would increase the present number of uses of Ohio's stone.



LIMESTONE and DOLOMITE

OCCURRENCES & RESERVES

Ohio's limestones and dolomites were deposited in seas and lakes which covered much of the state during various geologic periods. Most of these rocks are found at the surface in the western half of Ohio. The surface rocks of eastern Ohio overlie and are younger than those of western Ohio and contain more shale and sandstone. The limestones and dolomites present in eastern Ohio are generally thinner and of a poorer quality than those in the western part of the state. The accompanying map shows this distribution of Ohio's limestone and dolomite resources.

The chemical quality of the Ohio limestones varies from one formation to the next. The high-calcium limestones are the Brassfield, Columbus, and Maxville formations. The Vanport, Putnam Hill and Ames limestones of the Pennsylvanian system are also locally of high-calcium quality and thick enough to mine. The high-magnesium dolomites of Ohio are found in the Niagara group, and most of the production comes from the Guelph formation of this group. The remainder of the limestones and dolomites of the state are used for purposes for which chemical specifications are less rigid such as concrete aggregate and agricultural dust.

Dolomites are more abundant in Ohio than high-calcium limestones and are exposed at the surface in sufficient amounts to supply Ohio's needs in the foreseeable future. High-calcium limestones, however, are far less abundant, and surface deposits are rapidly being depleted by present production as well as being preempted by urban expansion and other land uses. The Brassfield, Columbus, and Maxville formations are being mined presently by underground methods; other formations which do not crop out in Ohio may be amenable to underground mining. One such formation is the Black River limestone. An analysis of samples from Hancock County oil well cuttings shows that it has a fairly high calcium content; in other areas its calcium content may be even higher. It is apparent, therefore, that Ohio's future as a high-calcium limestone producer will depend for the most part upon the stone that lies beneath the surface and that greater effort and expense will be required for its recovery.

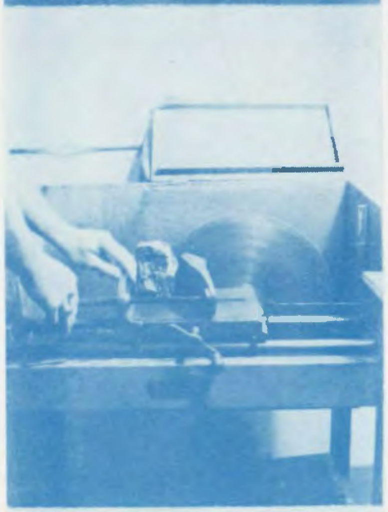
Limestone and Dolomite

Research

Geologic research on Ohio's limestones and dolomites includes both field and laboratory work. Field work consists of identifying the deposits, locating them on maps, measuring their thicknesses, determining their relationship to adjacent formations, measuring the amount and type of overburden, and collecting samples for laboratory study. Laboratory research may be considered a supplement to field work, for in the laboratory one is concerned with those properties of the rock which can not be determined conveniently in the field. Laboratory investigations include such studies as microscopic examination for mineral composition, chemical and physical tests to determine various inherent qualities of the rock, and economic potentialities of the deposit.

Recent research projects by the Survey involved the reconnaissance study of all limestone and dolomite formations in the state, results of which have been published in Survey Bulletins 42 and 49. The first of these bulletins covers the limestone and dolomite resources of western Ohio, and the second bulletin covers eastern Ohio.

At present the Industrial Minerals Section is conducting detailed economic and areal studies of the upper Niagara dolomite and the Brassfield limestone. In addition to these studies, the Areal Geology Section is conducting reconnaissance studies of various limestone and dolomite formations encountered in county-mapping projects.



The upper Niagara project is concerned with the determination of the geological relationships of the upper Niagara and Bass Island groups of dolomite. The project involves the areal mapping of the rock, measuring its thickness, and determining the amount of overburden covering it.

The primary purpose of the Brassfield limestone project is to determine the quality of the formation throughout its outcrop area in the state. It is known to vary from a high-calcium limestone to a shaly limestone, but the limits of these and intermediate phases have never been defined. The project involves measuring and sampling the Brassfield and laboratory analysis of the samples to determine their composition and physical properties, thus revealing areas where stone of fluxstone, cement or concrete-aggregate quality may be found.

Future geologic research involving Ohio's carbonate rock is dependent upon land use problems, for so much of the outcrop areas are being preempted for other purposes than mineral recovery. Thus, it is felt a thorough study should be made of the surface carbonate rock resources followed by investigations of the subsurface rock.

In Ohio high-calcium limestone deposits are less abundant than high-magnesium dolomites. It is felt, therefore, that research efforts should be first concentrated on proving potential high-calcium limestone deposits. The Survey's chemical analysis file reveals that at least locally the Black River, Brassfield, Lilley, Columbus, Maxville, Lower Mercer, Putnam Hill, Vanport, Hamden, Cambridge, Bloomfield, Ewing and Ames limestones contain better than 90% calcium carbonate.

The Survey will continue to pursue its carbonate rock research program according to the areal needs, availability of research equipment and physical facilities, and budgetary limitations.

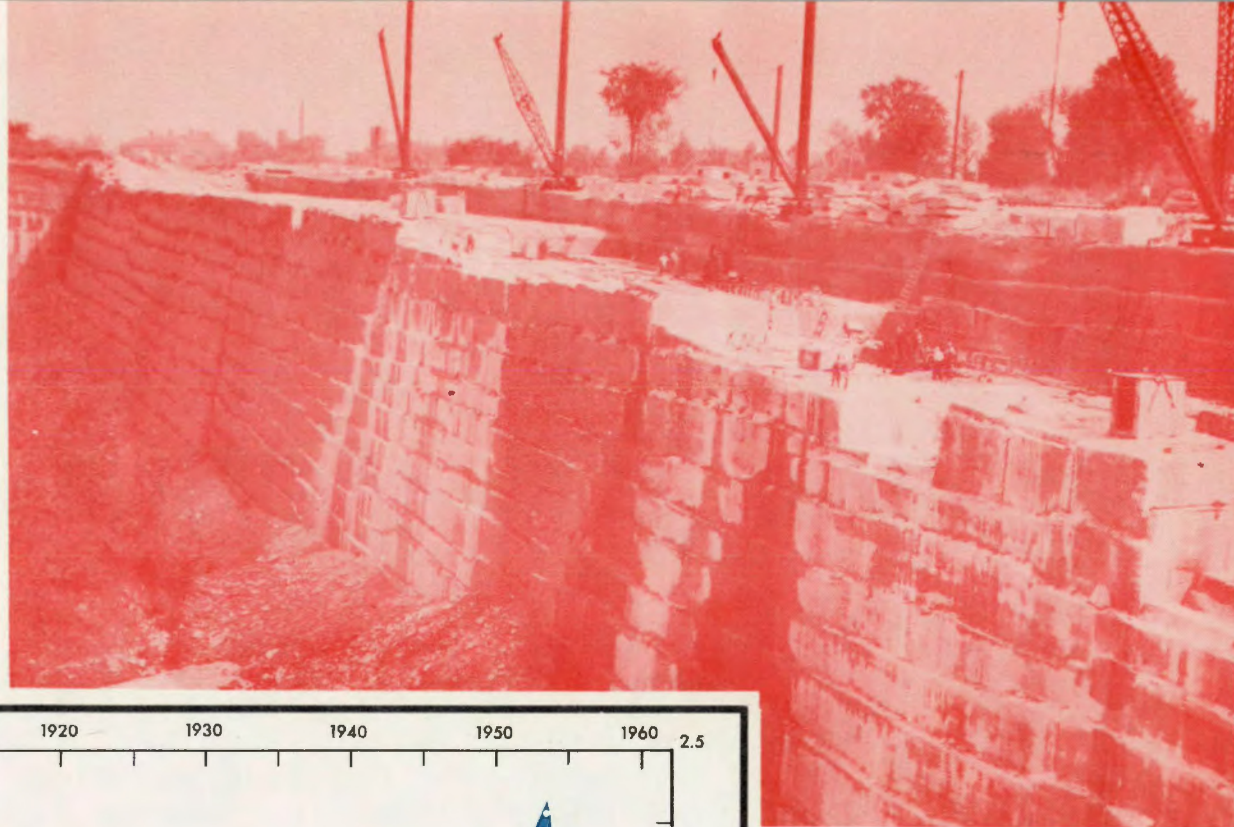
SANDSTONE

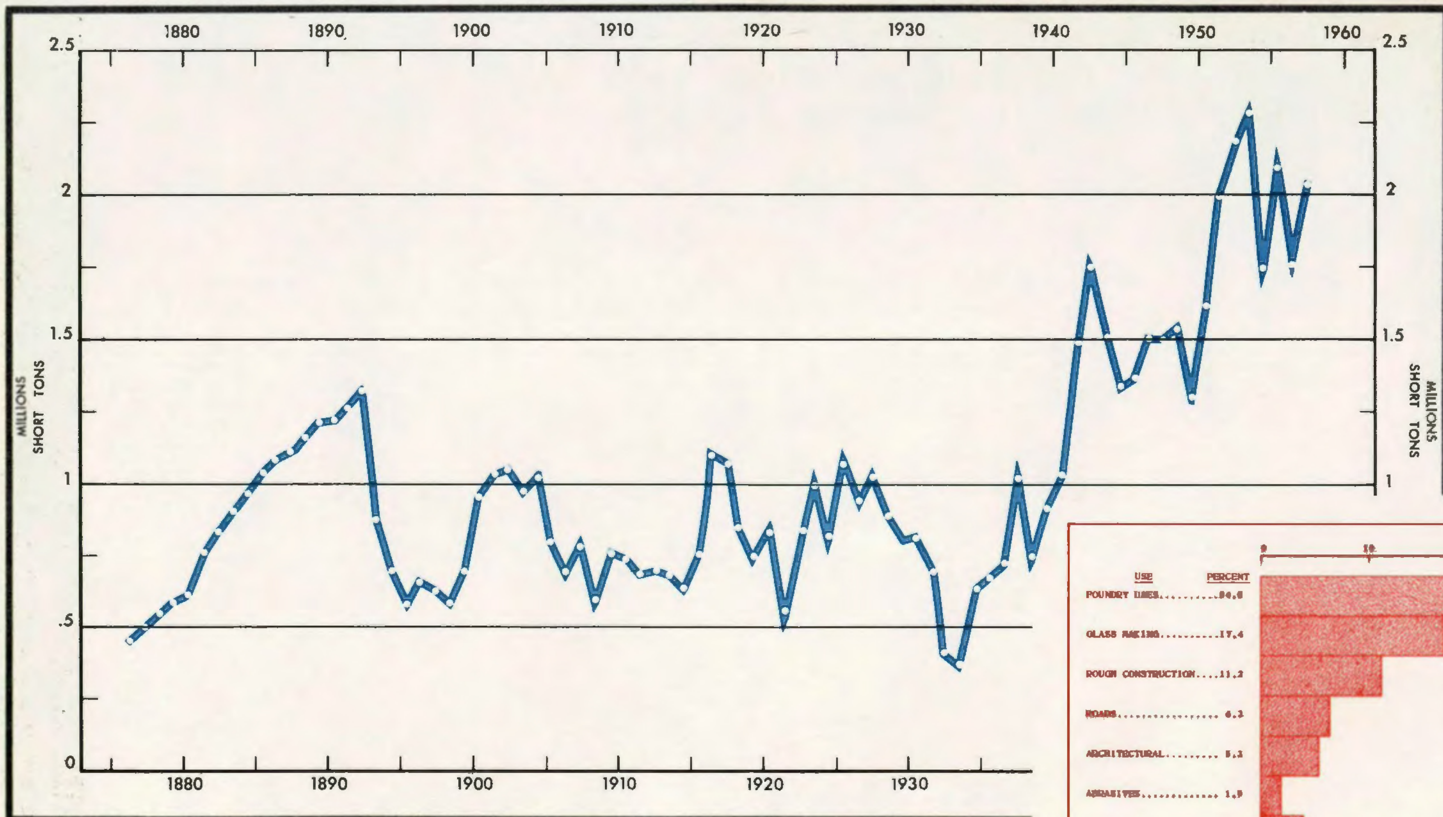
Ohio is first among the states in the production of sandstone. About two-thirds of all building sandstone used in the United States is produced in Ohio.

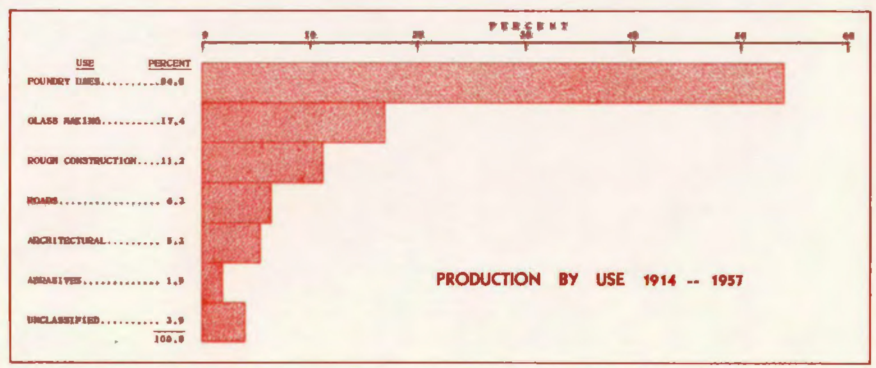
OHIO

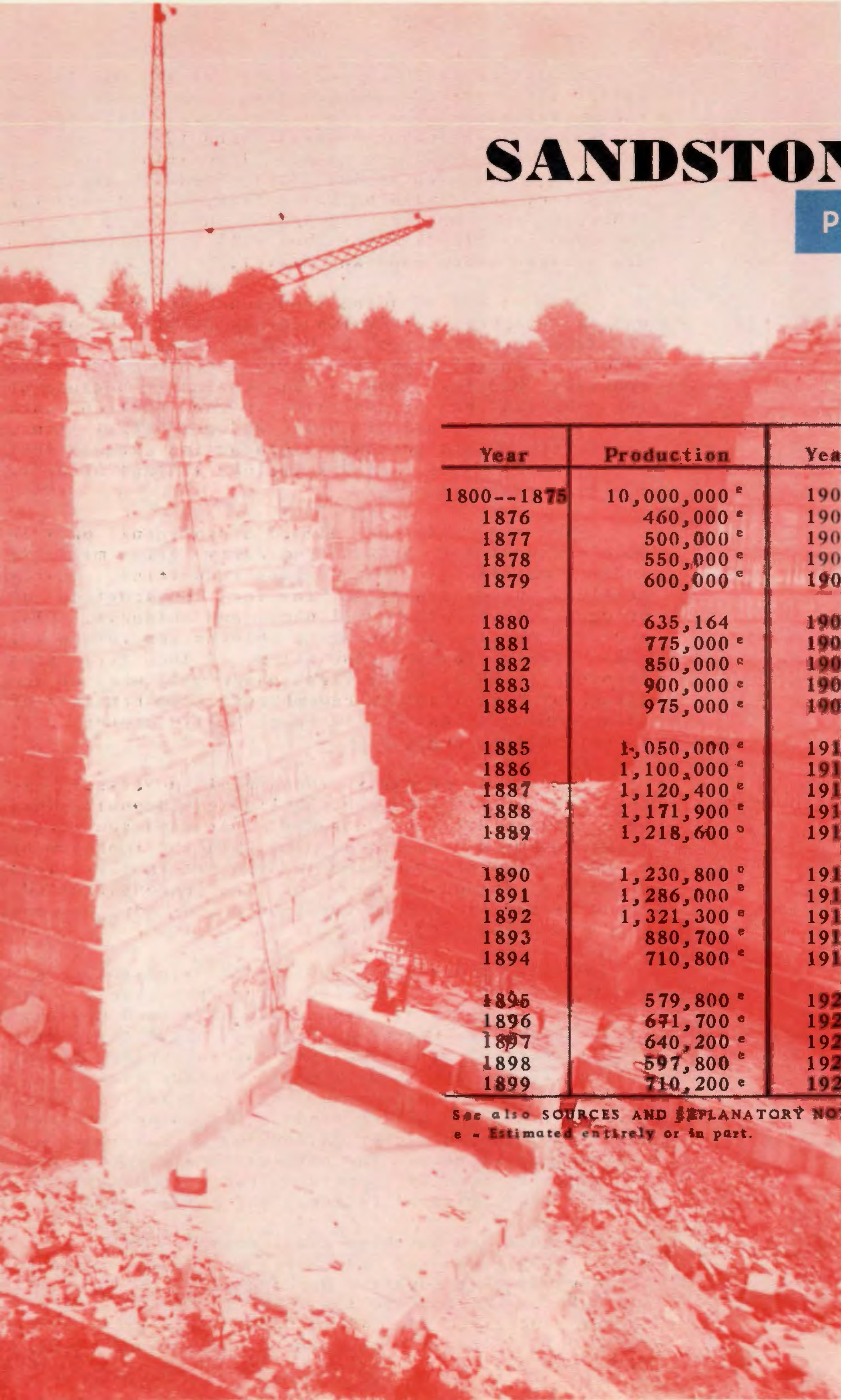
24

SANDSTONE Production









SANDSTONE

PRODUCTION

(SHORT TONS)

Year	Production	Year	Production	Year	Production	Year	Production
1800--1875	10,000,000[e]	1900	956,600[e]	1925	1,099,909	1950	1,607,687
1876	460,000[e]	1901	1,030,600[e]	1926	921,695	1951	2,006,234
1877	500,000[e]	1902	1,055,600[e]	1927	1,032,785	1952	2,184,588
1878	550,000[e]	1903	976,000[e]	1928	895,809	1953	2,309,005
1879	600,000[e]	1904	1,030,200[e]	1929	814,432	1954	1,712,482
1880	635,164	1905	796,200[e]	1930	824,315	1955	2,132,603
1881	775,000[e]	1906	690,400[e]	1931	707,599	1956	1,753,820
1882	850,000[e]	1907	785,100[e]	1932	404,188	1957	2,054,400
1883	900,000[e]	1908	575,100[e]	1933	370,259		
1884	975,000[e]	1909	773,000[e]	1934	621,989		
1885	1,050,000[e]	1910	752,800[e]	1935	674,346		
1886	1,100,000[e]	1911	692,300[e]	1936	720,343		
1887	1,120,400[e]	1912	699,900[e]	1937	1,068,718		
1888	1,171,900[e]	1913	684,500[e]	1938	571,893		
1889	1,218,600[e]	1914	633,449	1939	913,940		
1890	1,230,800[e]	1915	744,888	1940	1,036,121		
1891	1,286,000[e]	1916	1,111,576	1941	1,503,817		
1892	1,321,300[e]	1917	1,078,615	1942	1,790,049		
1893	880,700[e]	1918	840,439	1943	1,518,962		
1894	710,800[e]	1919	749,614	1944	1,331,950		
1895	579,800[e]	1920	849,399	1945	1,371,310		
1896	671,700[e]	1921	474,205	1946	1,513,453		
1897	640,200[e]	1922	808,199	1947	1,515,353		
1898	597,800[e]	1923	1,032,097	1948	1,556,800		
1899	710,200[e]	1924	784,694	1949	1,304,743		

TOTAL

92,986,436

tons

See also SOURCES AND EXPLANATORY NOTES.

e - Estimated entirely or in part.

OHIO 26

SANDSTONE MEMORANDA

Sandstone is the prime source of all Ohio's industrial sands and construction sandstones. The industrial sands come from two sources: (1) bedrock formations, the major source; and (2) various deposits of unconsolidated sand. Industrial sands and sandstones are used in the steel, glass, abrasive, refractory and building industries. Sand used for concrete and mortar aggregate, however, is not included in this category but will be considered in the section under Sand and Gravel.

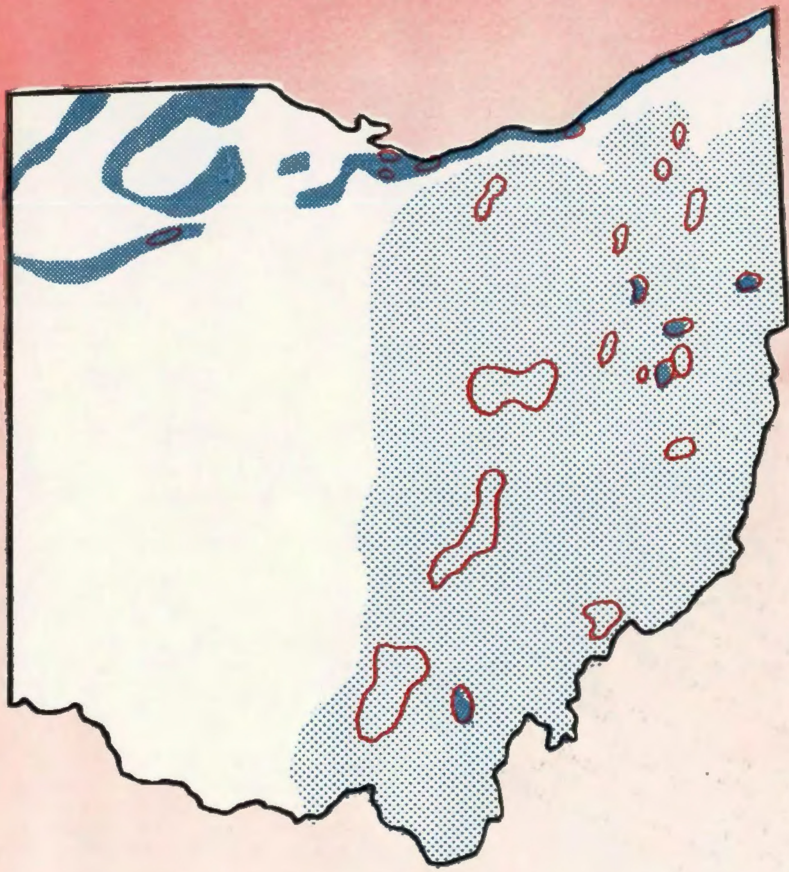
Ohio is the leading sandstone producer of the nation. Approximately two-thirds of all the building sandstone used in the United States is quarried in Ohio. In spite of this fact, the dimension stone industry has lost much of its business because of the substitution of concrete in construction work and the greater use of brick and artificial stone. Similarly, Ohio's grindstone production exceeds that of any other state but has yielded to that of artificial abrasive stone.

Sand and sandstone played a prominent part in Ohio's industrial growth from early grist mills to today's metallurgical and glass industries. Early settlers used sandstone in the construction of bridges, canal locks, mill dams, and chimneys. Disordered mounds of sandstone blocks are often all that remain to mark the sites of the first iron furnaces in Ohio. The first paper mill west of the Allegheny Mountains is remembered from remnants of stone abutments on the shore of Little Beaver Creek in Columbiana County.

Sand used in early industrial processes was obtained mostly from unconsolidated deposits that were located near the consumer. As sand specifications became more exacting, and with the improvement of quarrying equipment and transportation facilities, producers abandoned many of the unconsolidated deposits and turned to the purer and more uniform sandstone deposits.

Ohio's industrial sands and sandstones are today used in many manufacturing processes. The chemical and physical properties of a sand or sandstone determine its uses. Thus, one with a high silica content is used for manufacturing glass, silica alloys, and metallurgical furnace linings. Hardness and toughness are most important in abrasive, engine, and filter sands. Dimension sandstone must have pleasing color, strength, workability, and weather resistance. The physical and chemical properties are equally important for such purposes as foundry sand, mineral fillers, and potters flint.

In addition to these uses, many of Ohio's sandstone formations are reservoirs of oil and gas and are targets of a constant probing search into Ohio's subsurface. Even after they have given up their oil and gas supplies, many of the sandstones continue to serve Ohio's industry as natural underground storage tanks for gas.



UNCONSOLIDATED SAND DEPOSITS

SANDSTONE

PRINCIPAL PRODUCING AREAS

SANDSTONE

OCCURRENCES & RESERVES

Ohio's sand resources occur either as sandstones or as unconsolidated deposits. Sandstones are more widely used than the unconsolidated deposits because of their higher and more uniform quality.

Most of Ohio's sandstones are present in bedrock formations of Mississippian, Pennsylvanian, and Permian age. Those of most economic importance are: the Berea and Black Hand sandstones of Mississippian age; the Sharon, Massillon, Homewood, Clarion, Lower Freeport, and Upper Freeport sandstones of Pennsylvanian age; and the Upper and Lower Marietta sandstones of the Permian.

The unconsolidated deposits of Ohio are related to the glaciers that once covered much of the state. They are found in the beach ridges and dunes of ancestral Lake Erie in northern Ohio and locally throughout Ohio in present-day and ancient stream valleys.

SANDSTONE

RESEARCH

Research on Ohio's industrial sands and sandstones has been sporadic and has resulted in very little published material of economic or scientific value. The last comprehensive work ceased about 1911 with a partially completed study of the mineral content of the outcropping sandstones. Since that time the Sharon conglomerate has been the subject of several independent studies two of which have been published in short, technical articles. Most of the remaining work on Ohio's sand resources has stemmed from investigations by the Ohio State University Engineering Experiment Station.

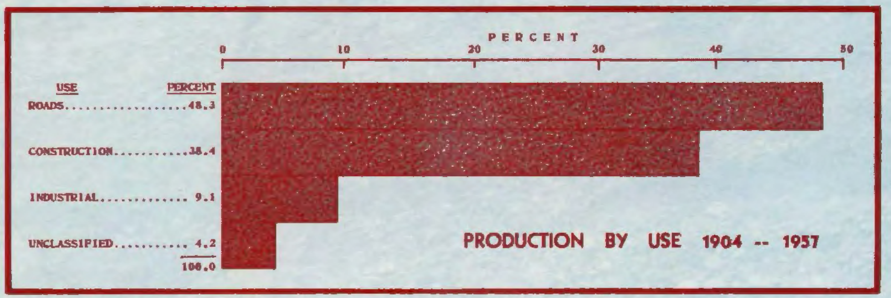
The requests for specific information by consumers, potential consumers, and producers of Ohio's sands and sandstones will, out of necessity, have to continue to go unanswered until geologic studies can at least pull abreast of the technological advances of industry. Evaluation studies to determine the greatest and most beneficial use of our many sand deposits present an open field for basic research.

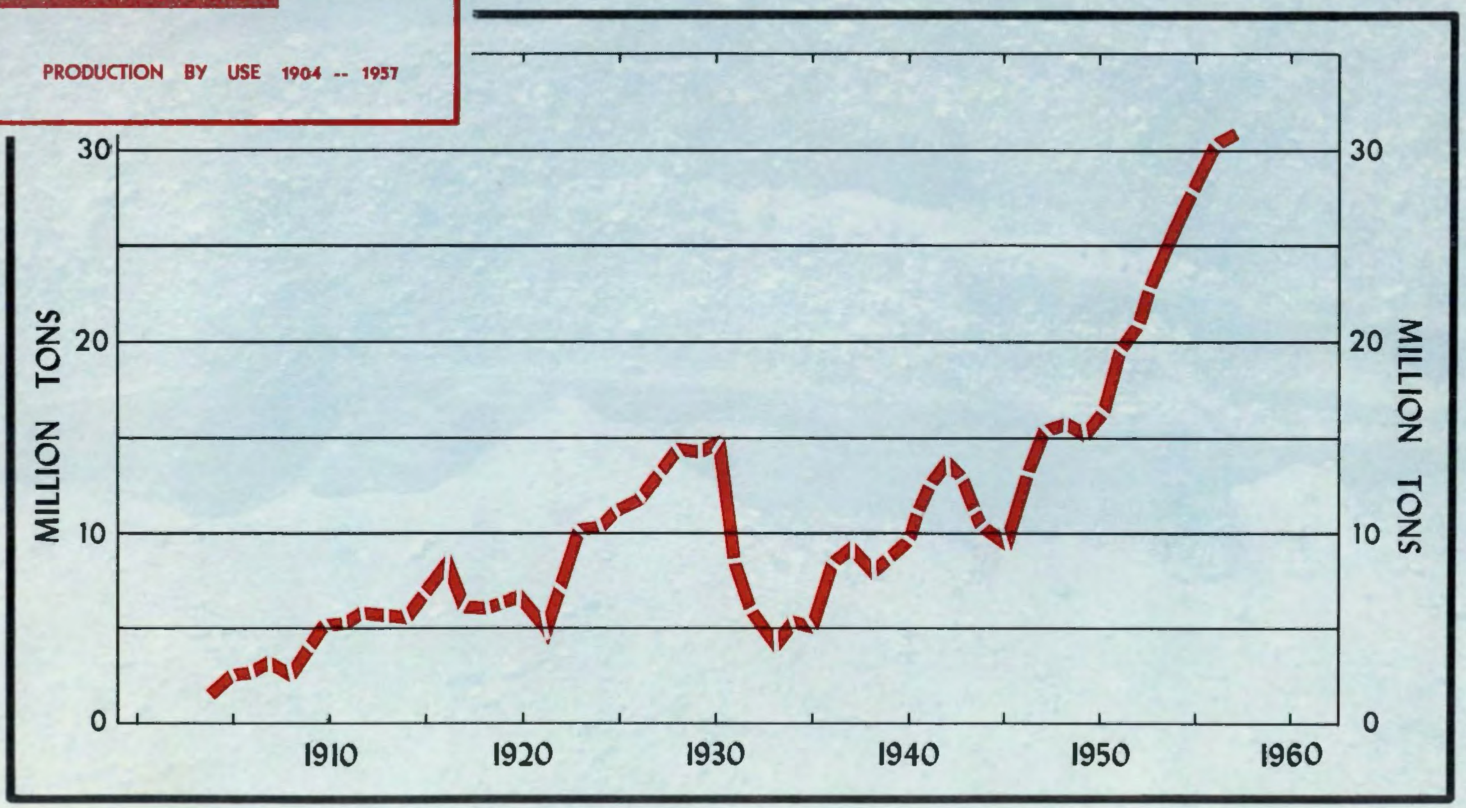
Future research should include basic mapping, sample collecting, and laboratory studies. Many laboratory analyses are needed in order to build up an adequate data library of the physical and chemical properties of Ohio's sands and sandstones. Such a library would be of great worth in evaluating their potential economic development.

Sand & Gravel

The great Pleistocene glaciers, which covered nearly three-fifths of the state, transported and sorted the materials which now make up most of the Ohio sand and gravel deposits.

SAND and GRAVEL
Production





Sand & Gravel

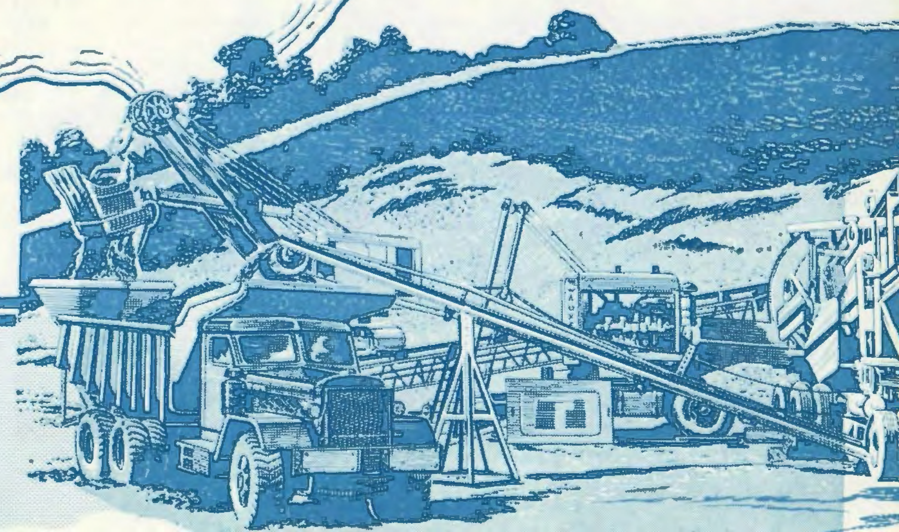
(SHORT TONS)

Year	Production	Year	Production	Year	Production	Year	Production
1904	1,367,134	1919	6,439,979	1934	5,257,514	1949	14,955,657
1905	2,281,839	1920	6,665,819	1935	5,045,695	1950	15,664,175
1906	2,424,274	1921	5,138,276	1936	8,250,474	1951	19,430,898
1907	2,978,801	1922	6,999,962	1937	9,198,577	1952	20,751,493
1908	2,496,710	1923	10,126,977	1938	7,942,506	1953	24,032,388
1909	4,015,373	1924	10,379,361	1939	8,660,485	1954	25,827,220
1910	5,106,514	1925	11,296,160	1940	9,558,904	1955	27,906,047
1911	5,281,637	1926	11,716,926	1941	12,473,145	1956	30,149,822
1912	5,874,412	1927	13,187,415	1942	13,753,393	1957	30,595,877
1913	5,605,767	1928	14,286,169	1943	12,569,930		
1914	5,510,879	1929	14,250,141	1944	10,327,012		TOTAL
1915	6,861,023	1930	12,679,854	1945	9,420,380		
1916	8,359,250	1931	8,387,377	1946	13,266,074		577,660,072
1917	6,187,978	1932	5,695,546	1947	15,388,990		
1918	6,001,240	1933	4,071,808	1948	15,508,815		tons

See also SOURCES AND EXPLANATORY NOTES.

OHIO

PRODUCTION



SAND and GRAVEL

—MEMORANDA—

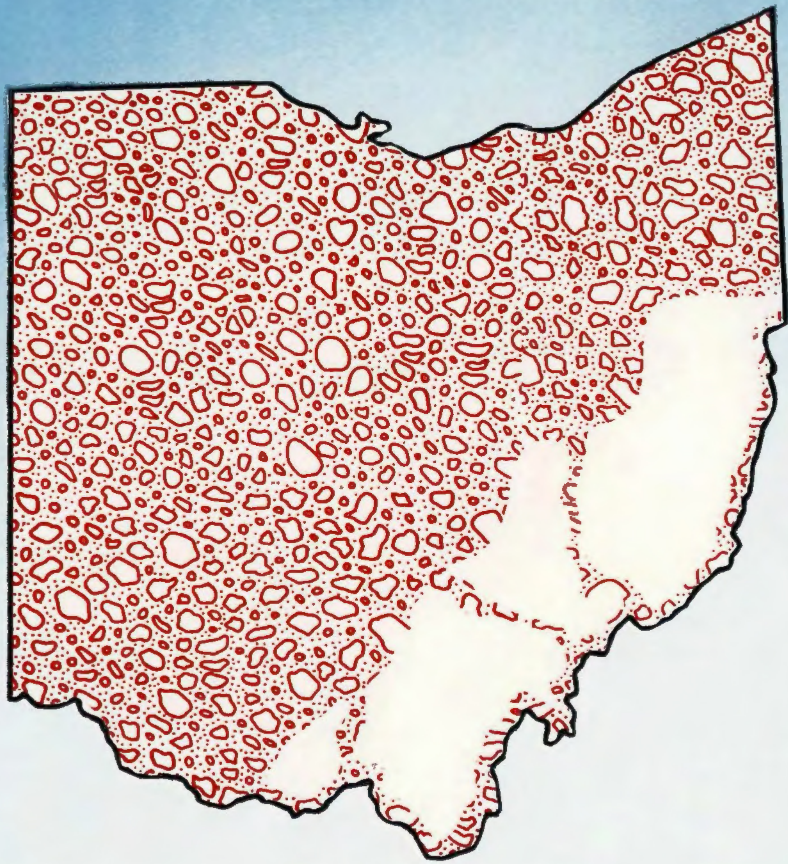
Sand and gravel are the plebeians among the mineral deposits of Ohio. As far as public recognition of relative importance among Ohio minerals is concerned, the sand and gravel resource has had a very low and humble rating. Yet in the matter of position in our state economy, it is of extraordinary value and has become as important as the construction industry itself.

At the beginning of the 20th century the sand and gravel industry was one of the smaller mining enterprises. In the past half century it has grown to a point where it is classified among the top three in annual production tonnage. According to reports by the U.S. Bureau of Mines, Ohio ranks fifth among the states in number of tons of sand and gravel produced. Ohio's tonnage during the last three years has averaged in excess of 29 million tons. The stability and progress of the industry are proved by the number of plants, the average production per plant, and the consumption of sand and gravel per capita, all of which have shown an upward trend for many years. The industry's 'coming of age' was pyramidal. Dirt roads were replaced with gravel roads, gravel roads in turn with concrete roads, and the initial concrete roads are now being replaced by super highways in which sand and gravel are frequently basic materials.

Sand and gravel have been used for numerous purposes throughout historic time. Sand became important as a mortar mix with the advent of lime; with the introduction of roman cement, both sand and gravel increased in utility. However, the invention of portland cement and steel-reinforced concrete brought the use of sand and gravel into its present prominence.

The principal uses for sand and gravel today are: as aggregate for concrete, as engine sand, filter sand, blasting, grinding and polishing sand.

Sand and gravel, among the most ordinary of raw materials, are basic to our way of life. The two, singly or in combination, provide the fundamental ingredients for homes, schools, churches, offices, highways, dams, bridges, skyscrapers, airports and all public works.



Sand & Gravel
OCCURRENCES & RESERVES

Ohio is blessed with extensive sand and gravel deposits located particularly in the valleys of the major streams such as the Miami, the Scioto and their tributaries. Because of differences in geologic history the character of the sand and gravel varies greatly. For example, many of the high quality sand and gravel deposits are found in the carbonate terrain of western Ohio.

The primary sources of sand and gravel deposits in Ohio are glacial and glacial-fluvial. The glacial deposits are confined to areas that have been covered by the great ice sheets of the past. The glacial-fluvial deposits represent terrace and outwash type deposits.

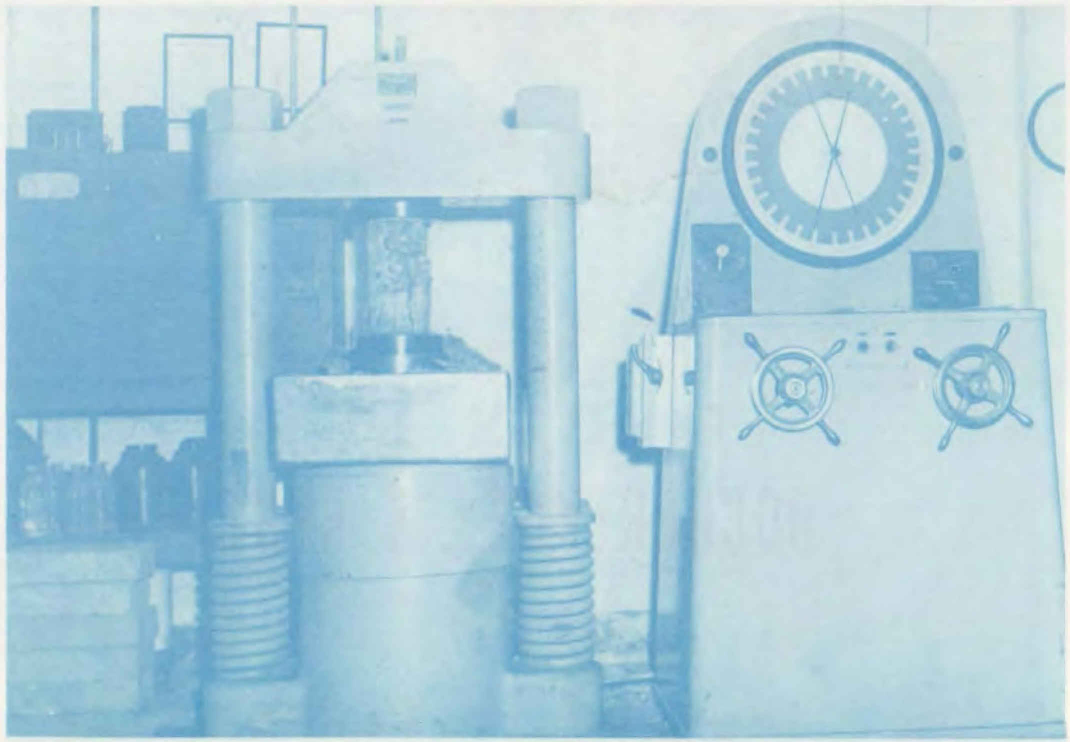
The remaining occurrences of sand and gravel are those associated with the beach ridge and dunes of ancient Lake Erie bottom deposits. The beach ridge and dune deposits account for a reasonable percentage of our annual industrial sands output. They consist mostly of sand and are commonly better sorted than stream deposits.

Most sand and gravel deposits are not sufficiently clean or properly sized to be used without some preparation. For this reason washing, screening and beneficiation plants have thrived and will continue to be necessary as the specifications for sand and gravel become more rigid. In general those deposits genetically related to a fluvial cycle are more economical to process for sand and gravel uses.

Ohio's sand and gravel deposits do not afford much in the way of by-products. Possible by-products such as gold, diamonds and 'black' sands are in such low percentage that recovery of these is not economically feasible.

Conservation of sand and gravel reserves in metropolitan areas of Ohio has become a major problem, and depletion of supply is threatened. Keen competition in the utilization of land underlain by sand and gravel deposits for other purposes is threatening the depletion of reserves. Future resources and reserves are dependent upon preservation of sand and gravel lands for the recovery of their mineral deposits rather than their exploitation for urban use.

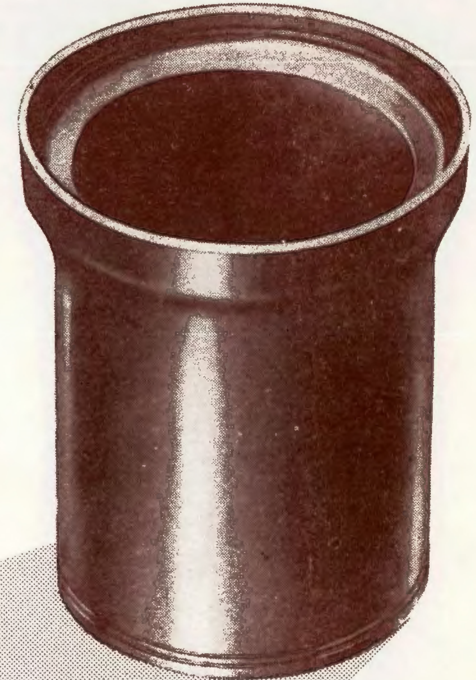
SAND and GRAVEL Research



A sand and gravel research program should be basic in its approach but applied in its scope and in its consideration of the problems facing the mineral industry. Field mapping of the terrain to determine the areal extent and continuity of sand and gravel deposits is an important first step. In large measure this first step has been completed by the Survey on a reconnaissance basis and is documented by maps in Survey files. These maps are available to the sand and gravel researcher or prospector. They show the location and extent of glacial deposits and can be amplified and extended by aerial photographic and additional field mapping studies. Such an inventory, if undertaken, would result in a well-documented record of Ohio's sand and gravel terrains.

Once an inventory is completed, a systematic study of the commercial quality of these deposits should be inaugurated. Such quality studies must include gradation ratio, gross specific gravity, and detailed mineral studies. Through detailed examination the relative abundance of specific types of rock and mineral constituents is determined; the physical and chemical attributes of each, such as particle shape, surface texture, pore characteristics, hardness, and potential alkali reactivity are described; coatings are identified and described; and the presence of deleterious substances is determined. These examinations require the use of petrographic and stereoscopic microscopes, x-ray diffraction and differential thermal analysis equipment. Mineral examination of concrete aggregate is of great importance as a supplement to standard acceptance tests which are universally applied by large and progressive engineering organizations. Many physical and chemical properties are not determinable by any standard tests, but merely estimated qualitatively in terms of their effect upon concrete. Research may better define these variables.

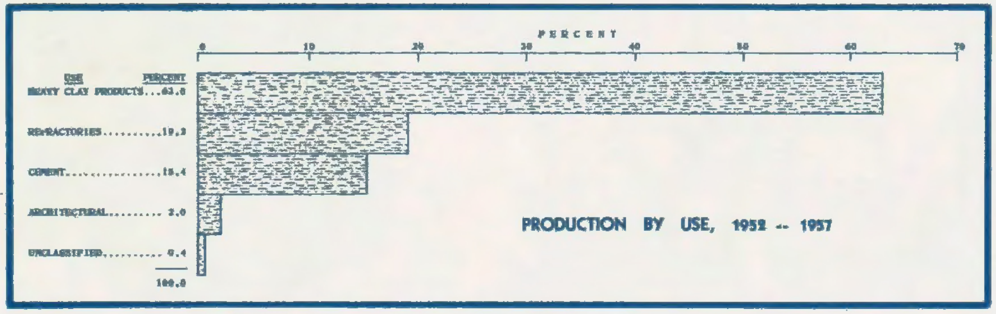
Sand and gravel are mineral resources essential to the growth and development of a modern industrial state. A future research program to facilitate the accumulation of basic mineral data needed to define areas and qualities of the sand and gravel reserves is advisable.



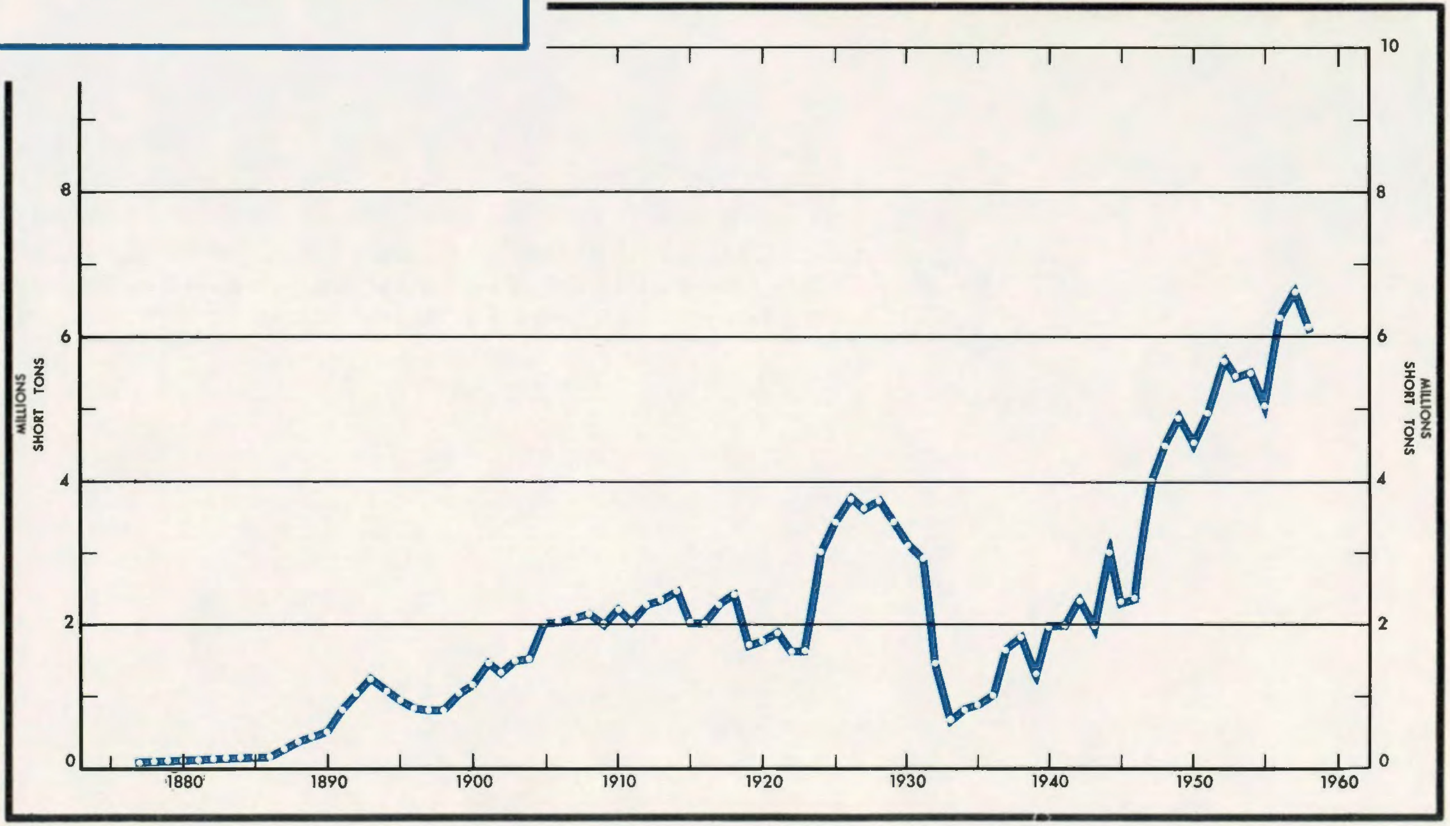
CLAY

Because of the abundance, quality, variety, quantity and distribution of its native clays Ohio has for many years maintained a leading position in the production of clay and in the manufacture of ceramic ware.

CLAY Production



PRODUCTION BY USE, 1952 -- 1957



(SHORT TONS)

Year	Production	Year	Production	Year	Production	Year	Production
1800--1875	4,000,000[e]	1900	1,473,088	1925	3,790,733	1950	4,977,130
1876	100,000[e]	1901	1,337,181	1926	3,692,600	1951	5,686,630
1877	100,000[e]	1902	1,528,829	1927	3,731,181	1952	5,493,830
1878	100,000[e]	1903	1,567,603	1928	3,401,995	1953	5,634,596
1879	110,000[e]	1904	2,045,848	1929	3,172,449	1954	5,051,478
1880	120,000[e]	1905	2,039,292	1930	2,294,324	1955	6,297,413
1881	130,000[e]	1906	2,126,179	1931	1,504,899	1956	6,702,531
1882	140,000[e]	1907	2,177,174	1932	627,211	1957	6,136,024
1883	150,000[e]	1908	2,004,019	1933	873,602		
1884	168,208	1909	2,289,088	1934	899,282		
1885	153,756	1910	2,028,852	1935	1,052,058		
1886	266,709	1911	2,309,188	1936	1,701,132		
1887	366,476	1912	2,353,510	1937	1,949,067		
1888	471,794	1913	2,442,121	1938	1,347,188		
1889	559,129	1914	2,006,380	1939	2,015,276		
1890	833,159	1915	2,049,664	1940	2,016,659		
1891	1,087,560	1916	2,353,465	1941	2,418,280		
1892	1,253,110	1917	2,413,380	1942	1,988,551[e]		
1893	1,032,348	1918	1,713,320	1943	2,906,970		
1894	942,913	1919	1,811,940	1944	2,341,310		
1895	844,832	1920	1,909,193	1945	2,385,764		
1896	827,540	1921	1,625,096	1946	4,047,818		
1897	822,727	1922	2,244,440	1947	4,562,985		
1898	1,026,923	1923	3,035,806	1948	4,963,581		
1899	1,173,697	1924	3,480,209	1949	4,510,131		

TOTAL

179,320,424

tons

e - Estimated

See also SOURCES AND EXPLANATORY NOTES.

Clay production

CLAY

MEMORANDA

The high degree of development found in Ohio's clay industry came about not alone through good clays, but also because we were fortunate in having skilled workers among the early settlers. Some of the pioneers were men who had received training in clay technology in the eastern colonies or in the mother countries of England, Holland and France. With the guidance of these talented artisans the industry was established with a progressive and earnest outlook.

An early record states that in the building of Campus Martius in Marietta in 1788-1791 "the houses were all provided with good brick chimneys, the brick being made upon the ground and burned by men experienced in that line of industry." Thus, brick making in Ohio began with the first permanent settlement and has continued without interruption to the present.

Native clays were also turned to profitable account in other kinds of ware. The pottery business appears to have begun October 1799 at Cincinnati, today widely known for its useful and beautiful ceramic products. The yellow ware industry, using native clays, was introduced in 1840 at East Liverpool, and with its success, the business evolved from yellow ware through iron, stone, china and semi-vitreous ware to the finest grades of translucent porcelains.

Fire brick for metallurgical and other purposes was first manufactured at East Liverpool about 1841. The industry gradually expanded from that region to the Sciotoville, Oak Hill, and Strasburg fields where flint clays of excellent quality were discovered.

The sewer pipe industry also originated and developed in Ohio, which state has remained in the lead both in quality and quantity of output. In 1851, to meet the demands for better drainage and sanitation in the rapidly growing urban areas, pipe was first fashioned in a crude way from shale. In spite of this humble beginning, there developed the immense expansion of the sewer pipe industry we know today.

The manufacture of fire proofing material from clay was introduced into Ohio in 1880; vitrified brick designed for paving purposes was manufactured at Malvern in 1885 from Middle Kittanning clay; electrical conduits were first made at Cuyahoga Falls as early as 1888; and the door knob business, which started at East Liverpool in 1845, gave rise in 1872 to the electrical porcelain industry.

It is apparent that the clays and shales of Ohio are well fitted for a wide variety of useful articles. These ceramic materials have excellent working properties because they are easily fabricated, are tough in the green state, dry rapidly, burn to a dense strong body, and have a pleasing, attractive color.

Our factories manufacture nearly one-fourth of the total ceramic production of the nation and every type of clay ware. Notable among the ceramic uses to which Ohio's shales and clays are put are: stoneware, yellow ware, Rockingham ware, fire brick, saggers, retorts, face brick, sewer pipe, wall coping, radial block, liner plates, flue lining, crucibles, ladle brick, wall tile, drain tile, chemical stoneware, garden pottery, insulating brick, and paving block. Ohio produces 25 percent of the face brick, 30 percent of the glazed structural tile, 15 percent of the refractory brick, 40 percent of the red earthenware, 35 percent of the sewer pipe and 60 percent of the garden pottery made in the United States.

The major non-ceramic industry uses of Ohio's shales and clays are in the manufacturing of cement and light weight aggregates.

OCCURRENCES & RESERVES

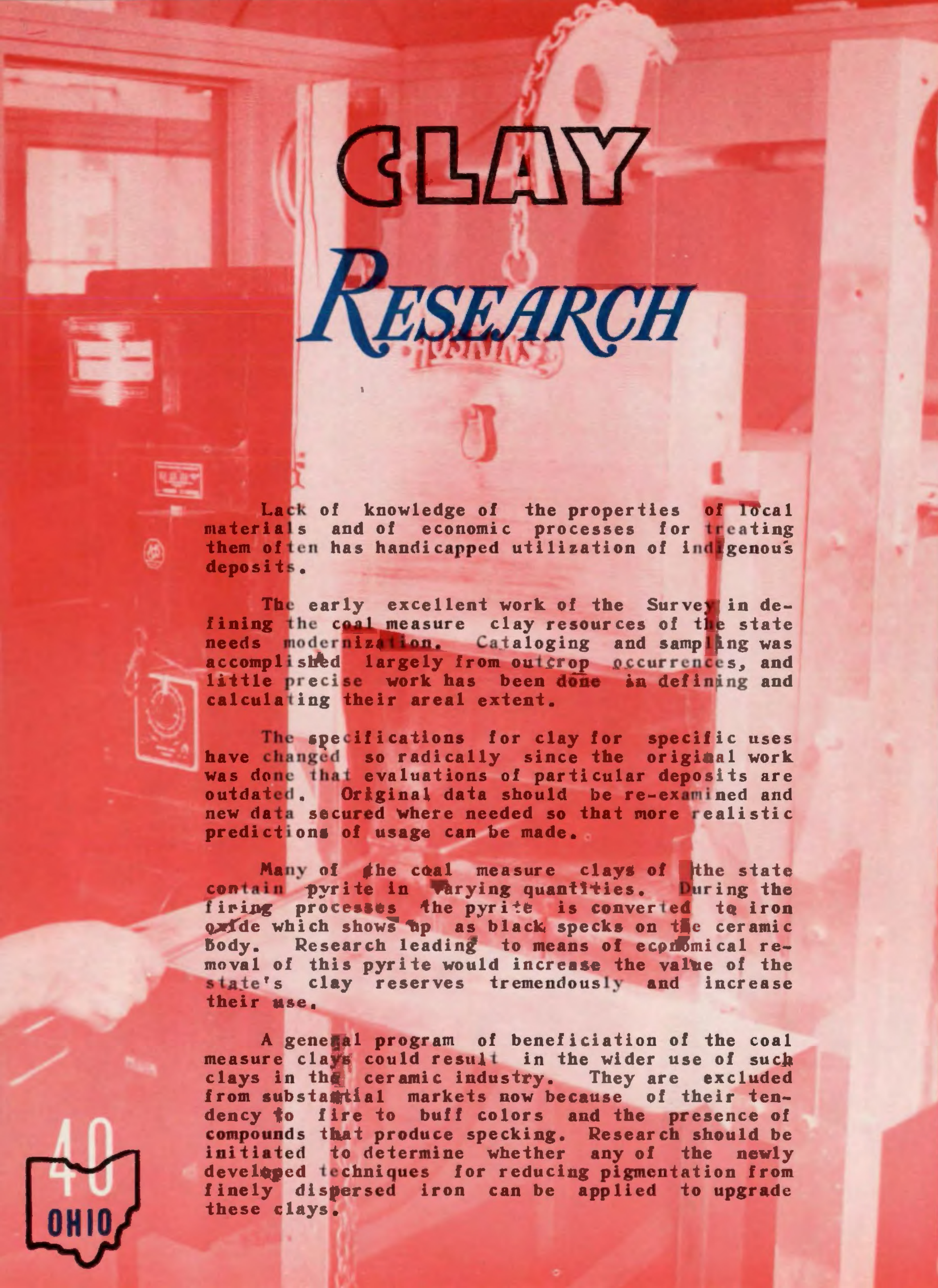
Ohio's native clays are coal formation clays, both flint and plastic, shales, alluviums, and glacial clays. Physically these clays can be grouped into the buff-burning clays and red-burning clays.

In Ohio the buff-burning clays are confined to the coal formations which occupy an area of approximately 12,350 square miles in the eastern and southeastern parts of the state. Some of the clay strata are very persistent, whereas others are patchy or confined to relatively small areas. Good examples of the persistent strata are the Mercer and Lower Kittanning clays; and of the patchy beds, the Sciotoville and Oak Hill members are representative. Clays of good quality are not uniformly distributed through the coal measures but are confined to definite horizons. The western portion of the coal measure province, Pottsville and Allegheny formations, contribute the majority of the buff-burning clay resources used for a variety of products from flue linings to high-quality refractory ware.

The red-burning clays are represented by the shales, alluviums, and glacial clays. The accompanying map shows in a general way the regions in which they are prominent. These materials are used mostly for building brick, paving brick, building block and drain tile. The Mississippian shales, Chagrin and Bedford members, are the most useful, but many other beds of clay or shale have good ceramic properties in local areas and thus help to swell the total clay products of the state.

Ohio has inexhaustible deposits of plastic fire clays, shales and usable surface clays, but it does not have clays that are used in china and porcelain, wall tile and other products classifiable as white wares. Nor does Ohio have deposits of minerals and clays high in alumina, such as are used in high alumina refractories.

Ohio's known reserves of flint fire clays have been largely exhausted. It is hoped that subsurface deposits will be discovered to replenish the reserves. Research investigations by the Ohio State University Engineering Experiment Station reveal shortage of suitable material for making light weight aggregate in some sections of the state.



CLAY RESEARCH

Lack of knowledge of the properties of local materials and of economic processes for treating them often has handicapped utilization of indigenous deposits.

The early excellent work of the Survey in defining the coal measure clay resources of the state needs modernization. Cataloging and sampling was accomplished largely from outcrop occurrences, and little precise work has been done in defining and calculating their areal extent.

The specifications for clay for specific uses have changed so radically since the original work was done that evaluations of particular deposits are outdated. Original data should be re-examined and new data secured where needed so that more realistic predictions of usage can be made.

Many of the coal measure clays of the state contain pyrite in varying quantities. During the firing processes the pyrite is converted to iron oxide which shows up as black specks on the ceramic body. Research leading to means of economical removal of this pyrite would increase the value of the state's clay reserves tremendously and increase their use.

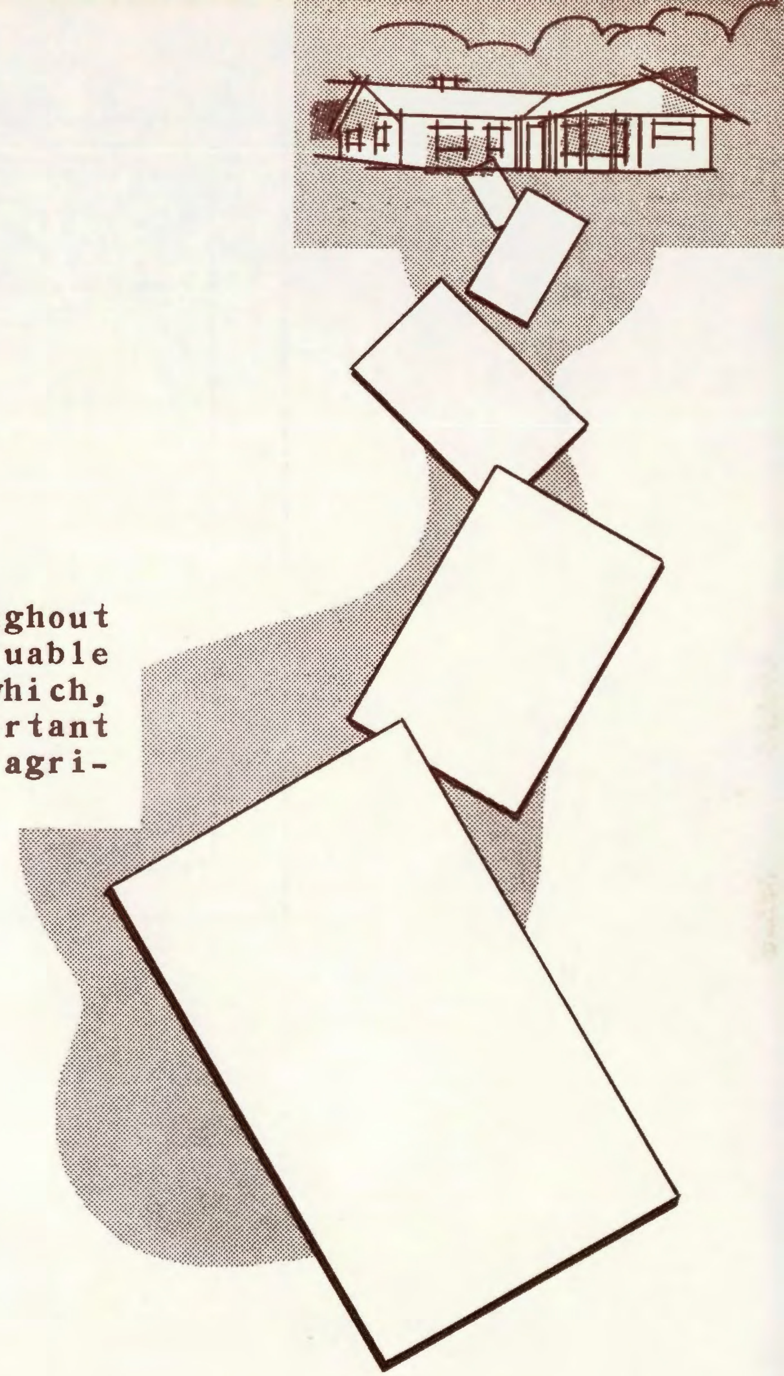
A general program of beneficiation of the coal measure clays could result in the wider use of such clays in the ceramic industry. They are excluded from substantial markets now because of their tendency to fire to buff colors and the presence of compounds that produce specking. Research should be initiated to determine whether any of the newly developed techniques for reducing pigmentation from finely dispersed iron can be applied to upgrade these clays.

In the course of testing certain shales in the state it has been noted that acid treatment removes the iron compounds to the extent that the resultant product fires to a white or light buff color. An investigation into the possibilities of upgrading and converting these materials into a new product could open up new fields of uses for Ohio's shales.

Reserves of highly refractory clay in America are being used up rapidly. Ohio has millions of tons of plastic fire clay that could conceivably be improved in refractory value by beneficiation processes. These processes consist mainly of removing free silica, micas and other minerals. Increase in refractory value would probably be accompanied by improved plastic bonding properties.

Ohio's known reserves of flint clays have largely been exhausted. It seems probable that the Sciotoville member of the Pottsville formation, which occurs mostly as hilltop deposits in southern Ohio, may extend under cover to the southeast. An exploratory program to locate this material should be initiated.

The Ohio State University Engineering Experiment Station has in the past done considerable research work on the clays and shales of Ohio. This has been done both as a service to industry and as basic research in the use of materials. Their facilities are available for continued development of Ohio's resources and the solution of industry's problems. The personnel of the Geological Survey and the Engineering Experiment Station make an excellent combination for pursuing research in the development of the ceramic resources of the state.

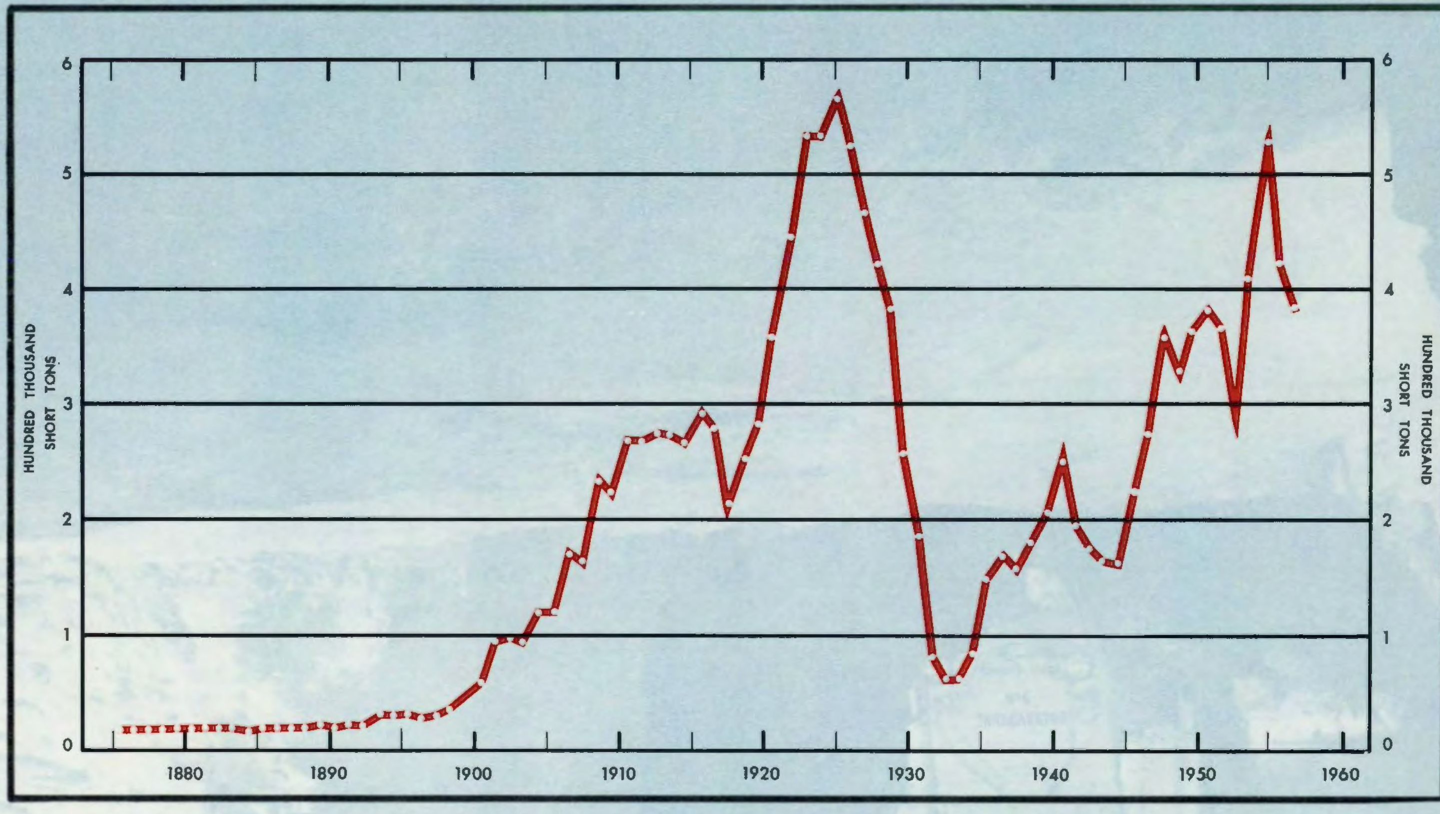


GYPSUM

Gypsum deposits occur throughout the world. The most valuable deposits, however, are those which, like Ohio's, are within an important construction, manufacturing and agricultural area.

OHIO

42



GYPSUM

production

(SHORT TONS)

Year	Production	Year	Production	Year	Production	Year	Production
1821--1875	200,000[e]	1900	39,034	1925	562,928	1950	362,221
1876	5,000[e]	1901	51,900[u]	1926	524,317	1951	377,321
1877	5,000[e]	1902	84,980	1927	474,318	1952	358,209
1878	5,000[e]	1903	88,560	1928	424,899	1953	281,354
1879	5,000[e]	1904	85,063	1929	374,007	1954	420,714
1880	5,000[e]	1905	112,657	1930	255,337	1955	529,116
1881	5,442	1906	112,202	1931	153,202	1956	417,400
1882	6,768	1907	163,120	1932	74,284	1957	380,000[e]
1883	7,607	1908	154,436	1933	57,239		
1884	7,060	1909	228,804	1934	58,000[e]		
1885	5,254	1910	213,325	1935	85,328		
1886	7,162	1911	261,946	1936	142,162		
1887	7,500[e]	1912	262,551[u]	1937	163,006		
1888	8,000[e]	1913	268,261	1938	149,655		
1889	9,920	1914	265,091[u]	1939	173,786		
1890	12,748	1915	259,036[u]	1940	200,679		
1891	9,123	1916	286,678[u]	1941	249,607		
1892	13,275	1917	270,552	1942	190,424		
1893	11,646	1918	199,456	1943	170,517		
1894	20,827	1919	251,314	1944	160,000[e]		
1895	21,662	1920	281,118	1945	157,376		
1896	22,634	1921	363,905[u]	1946	218,514		
1897	18,592	1922	435,643	1947	267,539		
1898	21,303	1923	526,861[u]	1948	358,116		
1899	27,205	1924	525,485[u]	1949	322,891		

TOTAL

15,355,172

tons

See also SOURCES AND EXPLANATORY NOTES.

e - Estimated. u - From U.S. Geological Survey records.

GYPSUM PRODUCTION

GYPSUM

MEMORANDA

Gypsum is a soft mineral composed of calcium sulfate and water. Pure gypsum is white, but impurities such as iron oxide or magnesium carbonate impart other colors to naturally occurring varieties.

The outstanding characteristic of gypsum is its property of losing part of its water content when heated to a comparatively low temperature. This heating process is called calcining. When calcined gypsum is mixed with water it can be molded to any desired shape, and it will then harden and retain this shape. Most applications of gypsum are based on these calcining and molding properties.

Anhydrite is a mineral closely associated with gypsum both in occurrence and origin. It is chemically similar in that it is composed of calcium sulfate but dissimilar in that it contains no water. This difference, though seemingly insignificant, greatly affects its physical properties, and anhydrite presently can not be substituted for gypsum in most manufacturing processes. Anhydrite has limited use for such purposes as soil conditioning where all that is sought is a source of calcium sulfate, but it is generally considered an impurity in a gypsum deposit.

The major uses of calcined gypsum are for manufacturing plaster and plaster products such as base coating, lath and wall board for the building industry, plaster for holding plate glass during its grinding and polishing, and plaster for pottery molds. Other uses which consume smaller amounts of calcined gypsum are the manufacture of industrial fillers and polishing agents.

Uncalcined gypsum acts as a retarder in portland cement, and this use consumes more raw gypsum than all others combined. Uncalcined gypsum is also used to treat soils and brewery water and as a filler in some manufacturing processes.

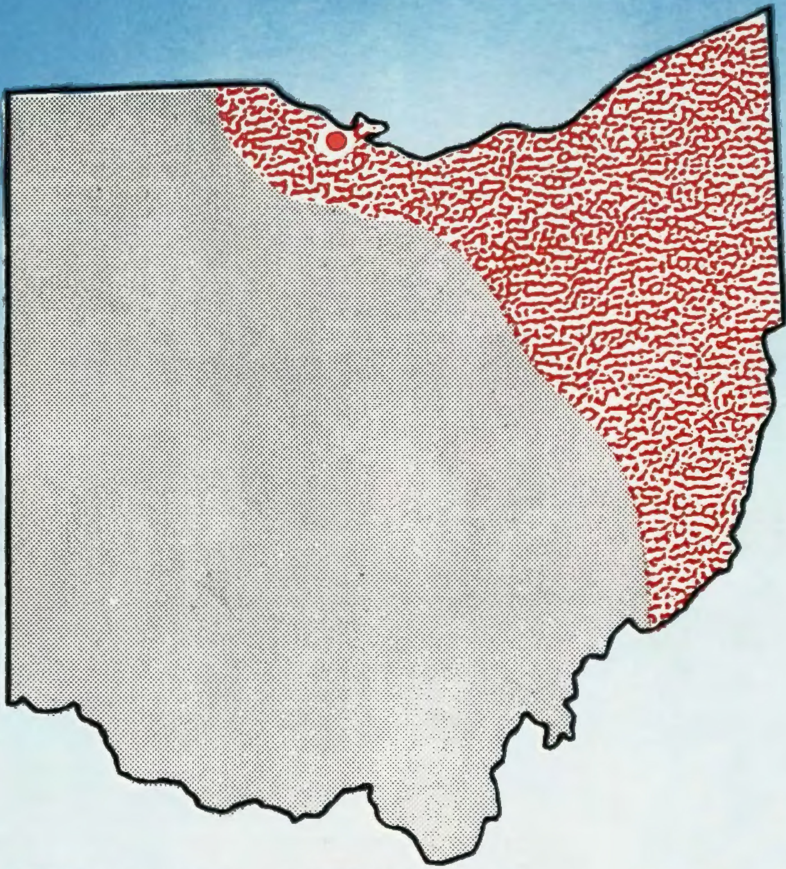
Gypsum consumption will increase with our expanding home, industrial and highway construction and will increase further as new uses are found for this versatile mineral. Experiments indicate that by adding more gypsum to cement, concrete products might be made more lasting; research such as this will extend the uses of the mineral and thus further assure continued markets for Ohio's gypsum.

Research is also being conducted on the utilization of anhydrite. Most of Ohio's calcium sulfate reserves are probably in the form of anhydrite rather than gypsum, and favorable results in this field will greatly increase the life of the gypsum industry in the state.

The history of Ohio's gypsum industry began in 1821 when two boatmen discovered gypsum outcropping along the north shore of Sandusky Bay. In the spring of 1822 quarrying was begun at the deposit along the shore, and a combination mill and dock was erected. The quarrying of gypsum has continued throughout the years since its discovery, years which were comparatively uneventful except for continued expansion of the industry.

GYPSUM

OCCURRENCES & RESERVES



GYPSUM - PRODUCING AREA

AREA OF REPORTED GYPSUM OCCURRENCE

Gypsum deposits have been reported from a broad area in northern and eastern Ohio, but the only deposits known to be of any economic value are those in Ottawa and Erie Counties north and south of Sandusky Bay near the original discovery site. The deposits on the north side of Sandusky Bay are presently being worked. The Erie County deposit is not being worked now but was at one time, and little is known about the extent of gypsum there.

The Sandusky Bay deposit occurs at and near the surface in Upper Silurian strata which are known as the Bass Island group. West of this occurrence gypsum has been found in the Bass Island group but not in sufficient quantities to warrant mining. East of the Sandusky Bay deposit the rocks dip beneath the surface, and minor amounts of gypsum have been reported at depth over a wide area of eastern Ohio from rock cores and well cuttings taken from the subsurface Upper Silurian strata. Some of this subsurface material reported as gypsum is probably anhydrite and is therefore valueless in our present mineral economy.

OHIO 46

GYPSUM Research

It has been pointed out that gypsum has been reported from the subsurface over a wide area of the northern and eastern parts of the state but that most of this is probably anhydrite rather than gypsum. It is apparent, therefore, that Ohio's future as a gypsum producer is dependent upon geologic exploration for economic subsurface deposits along with research on the utilization of anhydrite.

The Ohio Geological Survey has records of and some samples from wells which reportedly have penetrated gypsum deposits. Using this information as a basis, geologic study is needed to determine the location of economic deposits of gypsum. Such a study should differentiate the areas of gypsum and anhydrite occurrence and determine what geologic factors control the localization of each occurrence. It is not perfectly understood how gypsum and anhydrite deposits were formed, and a better understanding of the geologic origin will help predict where they might be found.

Research on anhydrite utilization should investigate two general possibilities: (1) the conversion of anhydrite into gypsum, and (2) the direct use of anhydrite. It has been demonstrated in the laboratory that, if anhydrite is first dissolved in water, it will recrystallize as gypsum. Research should be directed toward developing an economic method of doing this on a commercial scale.

The direct use of anhydrite has been given considerable attention in England and Europe where it is being used in the manufacture of sulphuric acid, cement, ammonium sulfate and some types of plaster. Competition from other sources of these products has prevented their manufacture from anhydrite in this country. However, Ohio's geographic position in and near a vast market area might provide the right conditions for the manufacture of some of these products from anhydrite.

Ammonium sulfate fertilizer can be produced by treating anhydrite or gypsum with ammonium carbonate or ammonia and carbon dioxide gases. The product is a mixture of ammonium sulfate and calcium carbonate and has an advantage over other ammonium sulfate fertilizers in that it reduces soil acidity caused by plant absorption of ammonia from the ammonium sulfate.

Both cement and sulphuric acid can be obtained from anhydrite or gypsum in one manufacturing process. This would be well worth investigating, particularly for those areas where existing cement plants are near anhydrite or gypsum deposits.

Research today can turn our seemingly worthless deposits into the valuable resources of tomorrow.

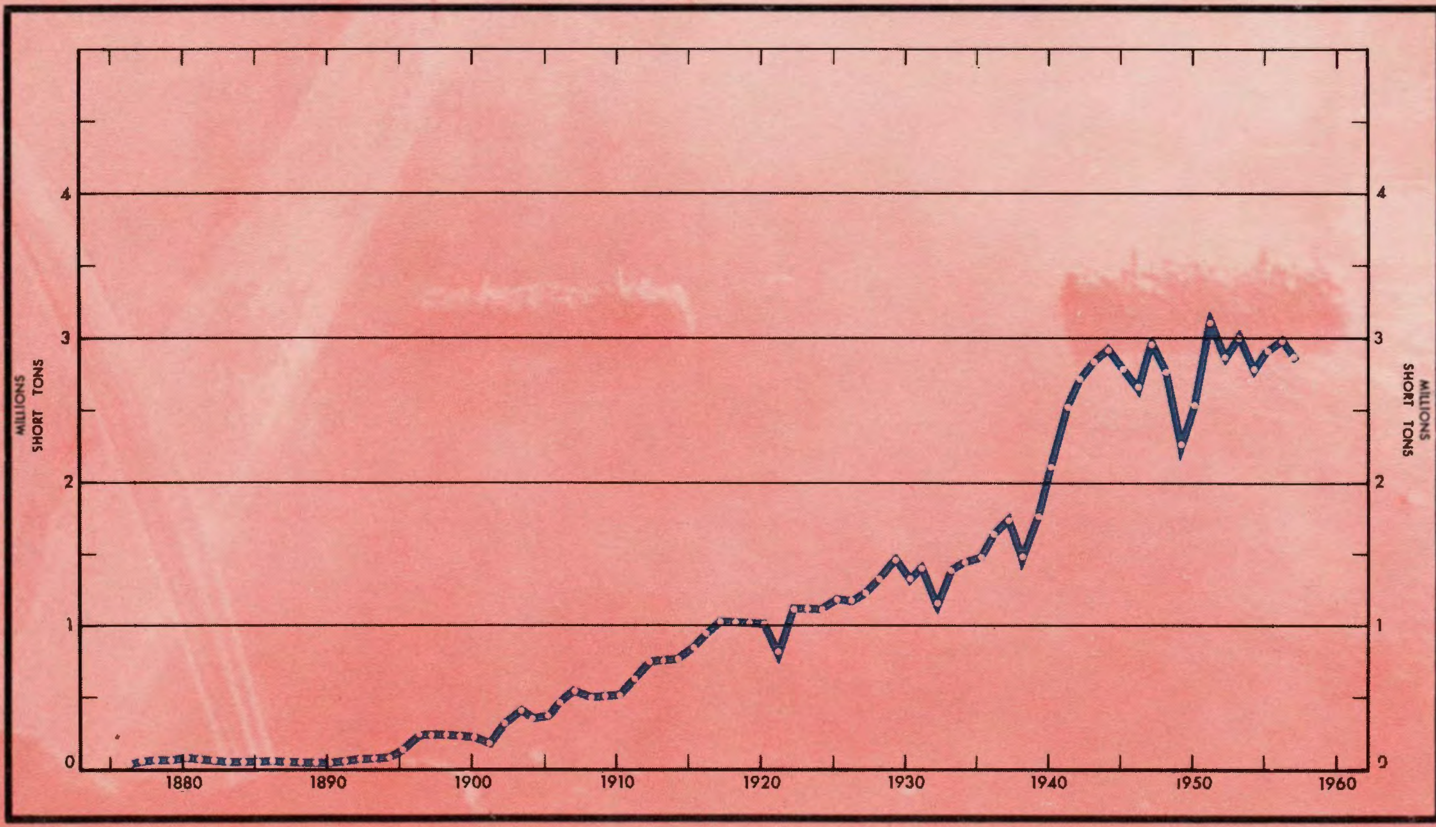
SALT

The extraction of salt is Ohio's oldest industry. Salt, together with limestone, is the foundation upon which the state's great chemical industry is built. Ohio ranks fifth among the states in its production.

OHIO 48

SALT

Production



SALT Production

(SHORT TONS)

Year	Production	Year	Production	Year	Production	Year	Production
1800--1875	2,000,000e	1900	199,540	1925	1,173,590	1950	2,515,205
1876	20,000e	1901	161,495	1926	1,164,400	1951	3,112,472
1877	30,000e	1902	295,398	1927	1,203,170	1952	2,827,455
1878	40,000e	1903	391,846	1928	1,308,110	1953	3,040,237
1879	50,000e	1904	343,816	1929	1,449,360	1954	2,748,993
1880	74,208	1905	353,718	1930	1,311,440	1955	2,905,028
1881	70,000e	1906	453,150	1931	1,398,000	1956	2,971,702
1882	56,000	1907	539,174	1932	1,196,993	1957	2,824,878
1883	49,000	1908	479,847	1933	1,382,294		
1884	44,800	1909	515,869	1934	1,432,292		
1885	42,959	1910	514,339	1935	1,487,315		
1886	56,000	1911	602,351	1936	1,633,056		TOTAL
1887	51,100	1912	737,685	1937	1,733,875		91,515,471
1888	53,200	1913	743,419	1938	1,489,270		tons
1889	35,000	1914	767,597	1939	1,794,788		
1890	32,382	1915	823,234	1940	2,080,133		
1891	55,580e	1916	938,867	1941	2,510,096		
1892	64,400e	1917	1,026,803	1942	2,711,188		
1893	76,155	1918	1,089,887	1943	2,818,928		
1894	74,059	1919	991,730	1944	2,891,395		
1895	109,345	1920	1,057,802	1945	2,764,926		
1896	232,730	1921	749,349	1946	2,645,995		
1897	220,558	1922	1,105,757	1947	2,975,676		
1898	235,515	1923	1,102,387	1948	2,752,696		
1899	204,472	1924	1,102,214	1949	2,195,778		

See also SOURCES AND EXPLANATORY NOTES.
e - Estimated.

SALT Memoranda

In our daily lives we are surrounded by and dependent upon products made from or with the aid of salt. It has been estimated that there are about 14,000 known uses for this mineral.

Explorers of the Ohio country, as early as 1751, found the Indians recovering salt. These primitive salt works, first phase of the industry, were located chiefly in what is now Jackson County.

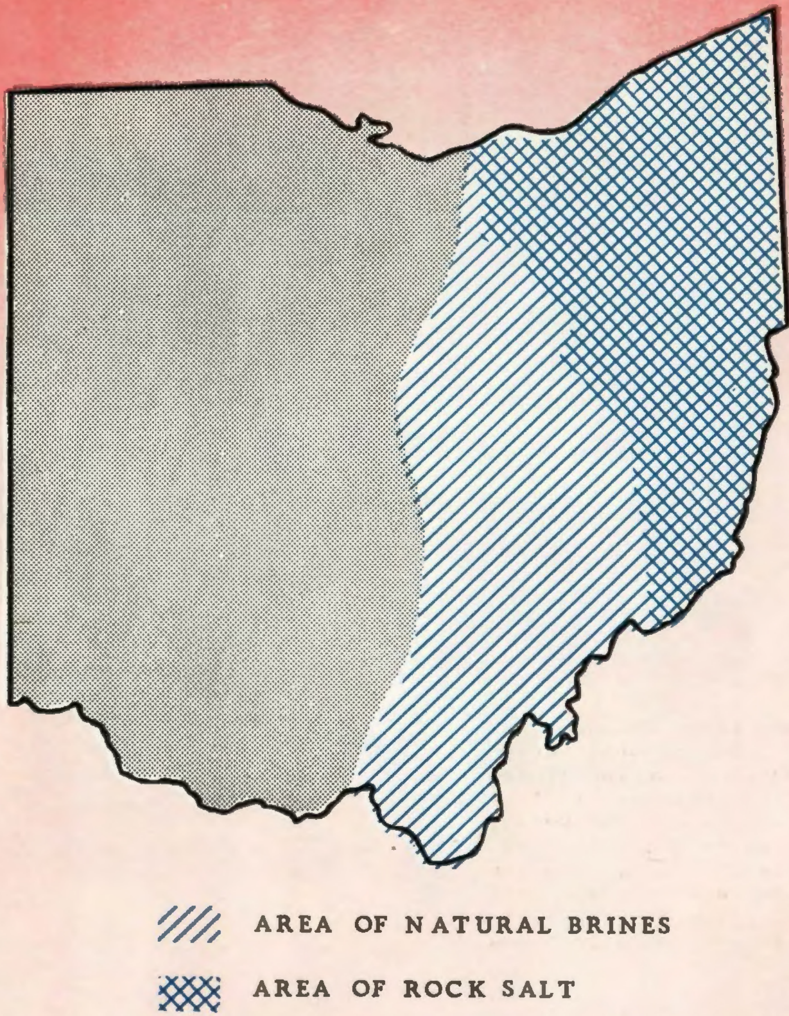
The United States Congress early recognized the importance of salt. With the Act of 1796, which provided for the sale of lands northwest of the Ohio River, the salt lick areas were set aside as public land. The enabling Act of 1802, which authorized statehood for Ohio, granted to the new state an area of 36 square miles containing the Scioto Salt Springs. The Act also provided that, if other licks were found, the enclosing land, 640 acres in area, would also be retained by the state and administered by the state legislature. The first state legislature met March 1, 1803, and one of its first acts concerned the leasing of the salt licks.

The first salt works in Ohio operated by white men were those located on Salt Creek, seven miles from Duncan Falls, in what is now Muskingum County. This salt manufacturing venture began in 1796 and continued until the Scioto Springs competition in Jackson County made the Muskingum project unprofitable.

From this time on every decade contributed an advancement of one kind or another. For instance, in 1809, the first Ohio salt well was drilled to a depth of 100 feet in Gallia County. By 1826 the public salt lands had been sold at auction reportedly because of unsuccessful operation by the state. Brines pumped from over 1,000 feet below the surface were being processed at Pomeroy in 1850, and by 1871 bromine was being recovered from brines at Canal Dover. Rock salt was discovered under the city of Cleveland in 1889, and a company was formed to recover salt from artificial brine by injecting fresh water from the surface. Ten years later the manufacture of soda ash by the ammonia soda process, utilizing artificial brines, was begun at Barberton. In 1957 a shaft was started in northeastern Ohio for the purpose of extracting rock salt at a depth of over 2,000 feet.

Evaporated salt is produced with two types of equipment: (1) grainers, consisting of large, shallow, open pans in which the brine is evaporated; and (2) the vacuum pan method, by which brine is boiled under high vacuum to evaporate the water. Salt companies in northeastern Ohio, operating with artificial brines, use both methods; those at Pomeroy, using bitterns, employ the grainer method only.

The soda ash and chlorine industries are the largest consumers of salt in Ohio. Other significant uses in order of their importance are: for livestock, meat packing, and table salt; in the manufacture of chemicals other than chlorine and soda ash; and in water treatment plants. Among the smaller consumers are: the soap industry, the tanning industry, and the glass industry. In recent years many new markets have been developed. Salt is now used in the manufacture of synthetic rubber and rubber-like materials, while the present emphasis on plastics is responsible for additional production. In the organic chemical industries many separations are based on a "salting out" process, and sodium chloride is usually used because of its low cost.



SALT
OCCURRENCES & RESERVES

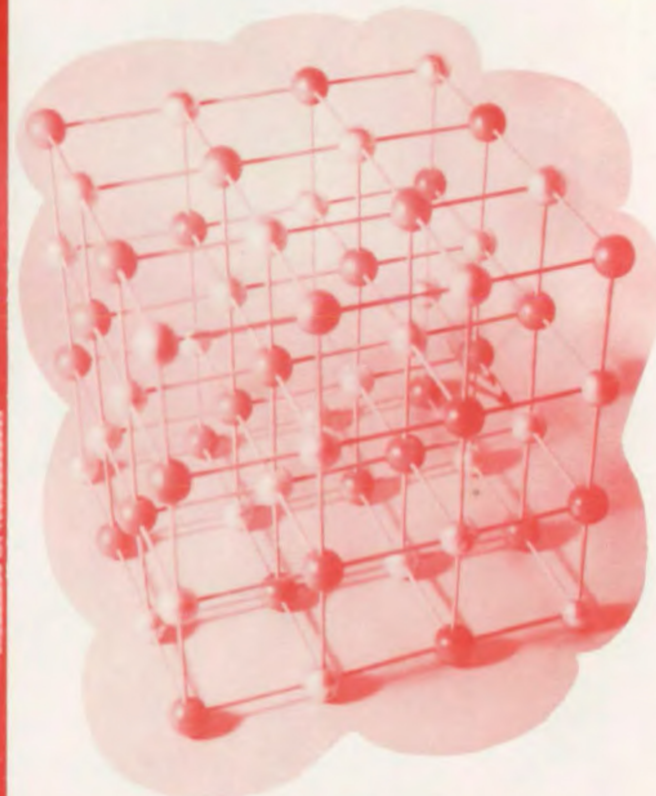
The salt deposits of Ohio are of two distinct types: (1) rock salt, and (2) natural brines. In general the brines are found closer to the surface than the rock salt deposits, and since they are in solution, it is only necessary to pump them to the surface for processing. The percentage content of sodium chloride in the natural brines is about half that of the artificial brines made from rock salt deposits. Natural brines contain about 10 percent sodium chloride, whereas the artificial brines from dissolved rock salt can be recovered with a concentration of about 20 to 25 percent sodium chloride.

Brines are usually present in most of the open, porous beds of sedimentary origin that are within the groups of strata partially or entirely of marine origin. In Ohio, saline solutions are encountered at various horizons throughout the rock column from the Cambrian to the Pennsylvanian system. The major brine producing units from oldest to youngest are: St. Peter sandstone, Salina group, Oriskany sandstone, Berea sandstone, Cuyahoga formation, Logan formation and Massillon sandstone. The present natural brine industry of Ohio is limited to Gallia County. Current knowledge suggests that the natural brines of Ohio are available in large quantities over wide areas.

Rock salt is a sedimentary rock and occurs in beds associated with other more common sedimentary rocks such as shales, sandstones, limestones, and dolomites. Commercial salt deposits in Ohio are limited to the Silurian system. The deposits are confined to eastern Ohio being present east of a line drawn from Lorain to Marietta. (See map.) Within the area of continuous rock salt the mineral varies in thickness and quality, but it has been estimated that sufficient salt is present to meet the demands of our growing population for many generations to come.

OHIO 52

SALT RESEARCH



There is much to be learned from geologic investigations of the rock salt and natural brine resources of the state. Subsurface mapping of the salt beds and brine horizons, for instance, is fundamental in the determination of their thickness, areal extent and stratigraphic position. The primary source of subsurface data for salt reserve interpretations is derived from oil and gas well drilling records. The mapping of the salt deposits is a part of the general subsurface investigations that are now in progress.

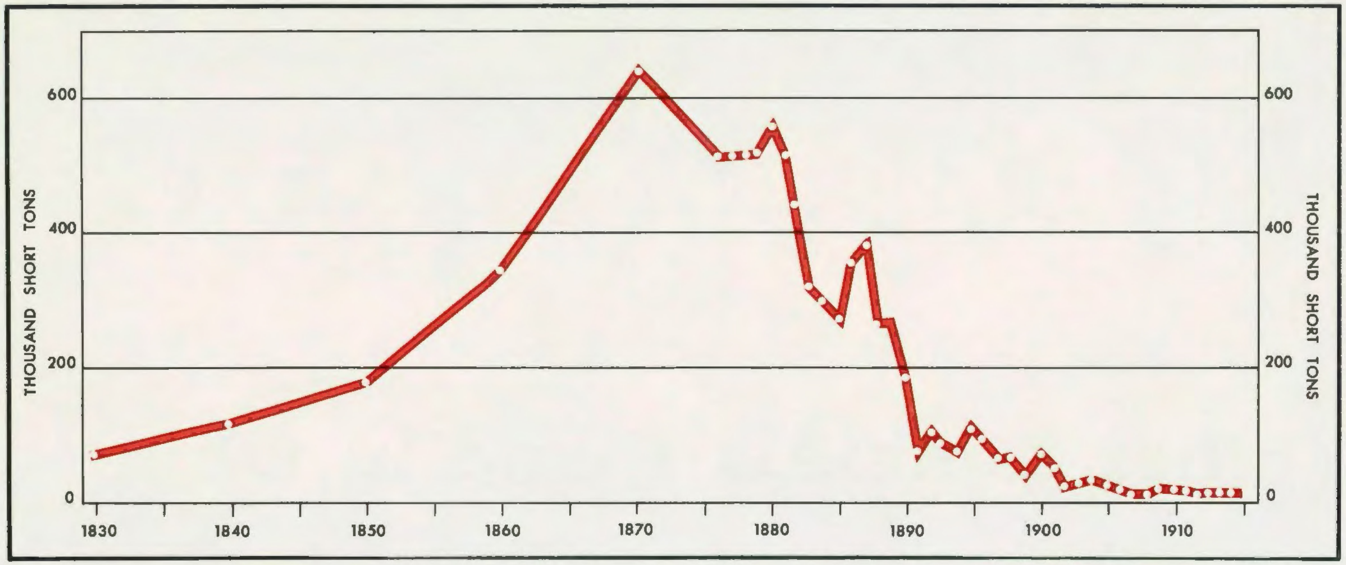
At the present time the Survey is involved in an investigation of Ohio's natural brines. This study involves the interpretation of brine analyses for various subsurface horizons with the aim of delineating areas in which various components of the brine are sufficiently concentrated to constitute commercial reserves of the individual elements.

The Ohio Geological Survey, in cooperation with the Department of Mineralogy of the Ohio State University, is engaged in a mineralogical study of rock salt deposits of Ohio. Until the initiation of this study no detailed investigation of the mineralogy of Ohio's salt deposits had ever been carried out. It is expected that this study will add substantially to the store of knowledge on the mineralogy of salt.

.....other minerals found in Ohio

IRON

PRODUCTION



(SHORT TONS)

Year	Production
1804--1875	9,000,000 e
1876	500,000 e
1877	500,000 e
1878	500,000 e
1879	500,000 e
1880	547,403
1881	500,000 e
1882	400,000 e
1883	300,000 e
1884	276,286
1885	259,581
1886	344,484
1887	377,465
1888	253,352
1889	252,409
1890	169,088
1891	67,984
1892	89,722
1893	68,260
1894	58,043
1895	93,051
1896	70,765
1897	50,267
1898	51,659
1899	25,359
1900	52,266
1901	41,325
1902	10,681
1903	12,995
1904	20,652
1905	14,207
1906	8,515
1907	2,423
1908	2,120
1909	12,392
1910	9,719
1911	7,624
1912	2,485
1913	4,778
1914	3,141
1915	3,668

See also SOURCES AND EXPLANATORY NOTES.
e Estimated.

TOTAL

15,464,169

tons

Iron is the most useful of all the metallic elements and, in its ordinary commercial forms, among the cheapest. Most rocks contain iron, but few are rich enough or of such physical and chemical nature as to constitute iron ore. The four major iron ore minerals are: hematite or red ore, magnetite, limonite or brown ore, and siderite or carbonate ore. Pyrite and other iron sulfides are minor sources. All these types of iron ore are found in Ohio except magnetite.

The local names of iron ore or miners' terms used in Ohio are numerous. The more prominent are block ores: Big Red Block, Little Red Block, and Sand Block; kidney ores: Red Kidney ore; shell ores, nodular ores, 'flag' ores, 'clayband' ores, bog ore, and others.

The Ohio iron industry began with the founding of Hopewell furnace in 1804 near Poland in Mahoning County and was projected into southern Ohio when Brush Creek furnace began operation in 1812 on Brush Creek in Adams County. Nearly 50 charcoal furnaces were built before 1845, the year coal began to replace charcoal as a fuel and when furnaces were constructed with larger capacities.

The second period of the iron industry may be considered as that from 1845 to 1870 when coke instead of coal had become the best known fuel for smelting, and Lake ores had partially replaced local ore supplies. Ohio had by this time established herself as a leader in the steel industry by virtue of the fact that her native ores yielded steel of excellent quality. But, the introduction of the rich Lake Superior ores caused many of the furnaces scattered among the hills of our state to close, and by 1880 the number of units dependent upon local ores had decreased substantially.

By 1890 many of the old furnaces were in ruins. Now many of the ruins have disappeared, and the furnaces are only a memory. However, the smelting of Ohio ores continued until about 1915, the period of such utilization was thus 111 years, from 1804 to 1915. In this period native ores supported 86 charcoal furnaces and 56 coal furnaces.

The furnaces and forges furnished the early settlers iron products necessary for a growing civilization. The list included many articles such as household goods, farm and mechanical tools, parts for machinery, engine cylinders and frames, cog and gear wheels, and even ordnance from rifles to large cannons. The iron industry had other aspects: it provided much employment both directly and indirectly, aided in opening the canal system, stimulated shipping on Lake Erie and the Ohio River, and was responsible for giving the first impetus to the Ohio coal industry. The early iron industry was thus a vital factor in developing the industry, commerce and trade of the state.

IRON

OCCURRENCES & RESERVES

The iron ores and ferruginous rocks of Ohio that were used for the smelting of iron are found in a wide expanse of strata, ranging from the Brassfield limestone in the Silurian System to the bog ores laid down since the retreat of the Wisconsin glacier.

The oldest rock in Ohio containing iron ore that has been exploited is the Brassfield limestone. Such ore is found in three counties of southwestern Ohio: Clinton, Highland and Adams. The Brassfield was mined at only one location, near Wilmington in Clinton County, to furnish ore for a furnace that failed to become commercial. The Brassfield ore is red hematite, consisting of flattened grains intermixed with the highly fossiliferous limestone. The rock is, in fact, a limestone rather than an ore.

The iron ores of potential value in Ohio are found among the rocks of the Pennsylvanian System, especially those of the Pottsville and Allegheny formations. Although deposits are quite abundant in this System, it is only in a few regions that they are rich enough, though nowhere sufficient in quantity, to sustain an iron industry in our present economy. A brief resume of iron ores of the Pennsylvanian System is furnished by Wilbur Stout in his Ohio Geological Survey Bulletin No. 45, 'The Iron Ore Bearing Formations of Ohio'.

It is not possible at this time to appraise the reserves of Ohio's iron ores because of lack of data. Available chemical analyses suggest most deposits are too lean in iron and high in the deleterious impurities to meet the rigid specifications of modern industry.

Though a vast number of deposits exist at various stratigraphic horizons, it is impossible to establish proven, inferred and potential ore tonnage figures until the areal geology mapping program now in progress has advanced considerably.

A possible potential source of iron ore is the deep-seated complex of rocks lying near the base of the sedimentary rock sequence. Exploration for this type of deep deposit will require extensive geophysical surveys, mainly magnetic, to determine the feasibility of further probing by core drilling.

Year	Production (SHORT TONS)
1935	2,580
1936	4,793
1937	3,160
1938	2,026
1939	1,623
1940	2,531
1941	1,495
1942	1,117
1943	739
1944	13,638
1945	14,434
1946	18,979
1947	17,784
1948	19,207
1949	20,372
1950	22,145
1951	21,378
1952	24,828
1953	27,696
1954	29,540
1955	22,484
1956	15,509
1957	5,478

SOURCE: Annual reports of U.S. Bureau of Mines and U.S. Geological Survey.

TOTAL 293,476 tons

PEAT

Peat is found scattered over the state in many marshy areas and lowlands. It occurs in beds varying from 1 to 30 feet or more in depth and from several to many acres in area. Combined areas carefully tested include some 150,000 acres or 235 square miles. Attempts have been made to utilize the peat in a few deposits for fuel. Aside from its fuel value, peat should be considered for its other useful properties. Peat is now used extensively for humidity control in greenhouses, for producing acid soils in rock and other gardens, for humidity and mineral retention base of fertilizers, and for filler for packing.

PYRITE [1]

Year	Production (SHORT TONS)
1897	500*
1898	1,000*
1899	2,500*
1900	5,000*
1901	7,585
1902	5,000*
1903	5,000*
1904	4,537
1905	8,944
1906	4,732
1907	6,816
1908	6,531
1909	9,461
1910	3,766
1911	6,471
1912	14,487
1913	13,622
1914	7,279
1915	10,887
1916	13,551
1917	13,218
1918	9,848
1919	4,609*
1920	3,000*
1921	2,000*
1922	1,000*
1923	138
1924	73
1925	100
1926	50*

* = Estimated from undistributed totals.
SOURCE: Annual reports of U S Bureau of Mines and U.S. Geological Survey.

TOTAL 171,972 tons

Pyrite or its orthorhombic form, marcasite, is a common, in fact too common, mineral present in an impure form in many of the coals and organic shales of Ohio. The mineral is the disulphide of iron, FeS_2. It was deposited largely with the original sediments in the form of grains, plates, or nodules. Slightly reducing conditions are necessary for formation. In some cases additional growth occurred around the original deposits through sulphur materials carried in by circulating ground waters. Pyrite is used for the production of sulphuric acid. In general, the manufacturers and largest users are the chemical and fertilizer industries. However, the acid finds application in many fields.

In Ohio pyrite has been produced in a desultory way for the acid trade for many years. Such material is gathered almost entirely from the refuse piles at coal mines, mainly in the east central and eastern parts of the state. The chief supply comes from the Lower and Middle Kittanning coals of the Hocking Valley and Tuscarawas Valley fields, from the Pittsburgh coal in the Belmont field, and from the Redstone coal in the Pomeroy field. The supply is large but the material grades low.

Formerly copperas was made at Steubenville and Cleveland by roasting the native pyrite gathered from the coal fields near by. Copperas is used as a mordant in dyeing cotton and woolem cloth; in making bright iron oxides, Venetian red, Spanish brown, etc., by conversion, for painters' colors; in paper mills, bleacheries, plate glass works, and chemical manufacturing establishments; in the precipitation of gold in leaching works; and to a slight extent in medicine.

1. From MINERAL RESOURCES OF OHIO by Wilber Stout, I.C. No. 1, Geological Survey of Ohio, 1946.

Sources and Explanatory Notes

SOURCES AND EXPLANATORY

NOTES

General

Ohio mineral production statistics, for the extended period reported here, are admittedly open to some criticism. The series is composed in part of arbitrary selections from conflicting reports published by equally authoritative agencies; some apparently incomplete reports have been used at times for lack of more adequate information; many of the estimates necessary to insure a more complete report could most certainly be questioned; and the definition of the mineral being reported needs interpretation in many cases.

Little more can be done to clarify the past, but a more intelligent approach to present and future reporting should be planned in order to avoid similar difficulties for interested individuals and agencies in years to come. The need for one official set of production data for the state is recognized, and plans are currently in progress to eliminate some of the confusion which has always characterized this field because of federal, state and private agency reporting.

If there is a consistent error in the series, it is our opinion that the reported production is in most instances somewhat short of the actual.

Coal

From coal production reports issued annually by the State of Ohio, Division of Mines and Division of Labor Statistics. For production by county, by strip or underground methods, and for individual years prior to 1876 see: Bituminous Coal Production in Ohio by County, 1800-1955, Division of Geological Survey, 1956. Data are reported in short tons and will vary somewhat from figures published by the U.S. Bureau of Mines and the U.S. Geological Survey. Losses incurred during the mining process have been estimated to approximate 50% so that the production figures here noted should be doubled to arrive at a true evaluation of the withdrawal from original reserves.

Oil

From reports of the U.S. Geological Survey and the U.S. Bureau of Mines. Production figures are reported in barrels of 42 gallons each.

Gas

From reports of the U.S. Geological Survey and the U.S. Bureau of Mines representing amounts produced and marketed. The production for years 1885-1905 has been estimated by Mr. K.C. Cottingham of the Ohio Fuel Gas Co. as a total of 320,000,000,000 cubic feet. The estimated distribution of this amount by years was made by applying the gas 'value' distribution available in annual reports of the U.S. Geological Survey for those years.

Beginning with the year 1947 production includes gas stored and gas lost in transit and is not strictly comparable with preceding years. Gross production figures from the U.S. Bureau of Mines beginning with the year 1935 and a series from the American Gas Association beginning with the year 1946 are recorded below for comparative purposes. The American Gas Association production figures for 1948 and thereafter are 'net' after deducting only the amount of gas returned to reservoirs for recycling and pressure maintenance.

Year	A.G.A. Production (MCF)	U.S.B.M. Production (MCF)
1935	-	52,000,000
1936	-	50,000,000
1937	-	45,500,000
1938	-	39,000,000
1939	-	44,000,000
1940	-	50,000,000
1941	-	51,200,000
1942	-	54,500,000
1943	-	63,000,000
1944	-	57,000,000
1945	-	55,000,000
1946	61,300,000	61,300,000
1947	74,000,000	72,860,000
1948	60,732,000	68,650,000
1949	47,000,000	49,100,000
1950	47,200,000	47,390,000
1951	41,400,000	41,500,000
1952	32,500,000	32,600,000
1953	31,280,000	38,200,000
1954	31,531,000	31,000,000
1955	35,081,000	35,000,000
1956	31,727,000	30,000,000
1957	32,261,000	32,500,000

Limestone

Production for the years 1800-1879 and 1881-1884 is estimated on the basis of data available in the files of the Ohio Geological Survey. Production for 1880 was reported in the U.S. Census for that year. The years 1885-1957 were copied from production reports issued annually by the State of Ohio. The years 1944 and 1946 are estimated in part, and the years 1914-1916 were revised to include an estimate of the stone burned into lime in instances where only the amount of lime was indicated. Limestone tables include dolomite insofar as it is possible to determine from the make-up of early reports. Original reports made in cubic feet, cubic yards or other measurements were converted to short tons.

Publications of the Survey consulted include: Annual Reports for 1837 and 1838; Reports of Progress for 1869 and 1870; Volumes V and VI; Bulletins 4, 13 and 18. (See Bibliography.)

Sandstone

Sandstone production figures for the years 1800 - 1913, at least as far as official records are concerned, are apparently non-existent. This situation is unexplainable in view of the fact that sandstone quarrying antedates limestone quarrying which had a much earlier first reporting year. There are, however, some points from which fairly adequate production estimates can be arrived at. For instance, the U.S. reports, confined to annual tonnage value for the 1887 - 1913 period, can be translated into tonnage by combing existing records for rates per ton of the various grades of stone. In the case of grindstones, a large percentage of the value of Ohio sandstone tonnage, this was fairly easily estimated, records throughout those years showing values varying from $8.00 to $18.00 per ton. Rough construction and architectural tonnages, because of the grade and use varieties, were somewhat more difficult to calculate and more open to criticism. Each classification presented its own problems, but in each instance the known uses to which sandstone was put aided the assignment of weights. Recorded uses include: bridges, dams and mills in the early years; canal lock and dam construction in the 1830's; most building foundations and chimneys before the appearance of cement and concrete; furnace linings, glass making, grave vaults; grindstones, millstones, and other abrasives; railroad beds, paving, flagging and curbing; public buildings throughout the years, but for the most part after the 1850's.

U.S. Census data on minerals provided other points of departure for estimates. With the critical assistance of staff geologists these estimates are presented as being probably within 20% plus or minus a true figure, a percent of accuracy which apparently is not exceeded by some of the early, published operator-reported figures.

Tonnage for 1914 to the present was copied from the Ohio annual reports, adjusted in some instances to include known deficiencies in certain years. This was especially true in the case of road materials and in the glass making industries. In most cases such adjustments were made from the 'Unclassified' group into these two areas. Reports made in cubic feet, cubic yards, or other measurements were converted to short tons.

Publications of the Ohio Geological Survey consulted included: First Annual Report, 1837, Second Annual Report, 1838, Vol. I, Vol. V, and Bull. 18. (See Bibliography.)

Sand & Gravel

From annual reports of the U.S. Geological Survey and the U.S. Bureau of Mines. In the case of all other Ohio minerals there were quite adequate records available in the publications and files of the Ohio Geological Survey on which to base fairly reliable estimates of production for the period from 1800 to the 1880's at which time most annual production returns became mandatory. Reporting of sand and gravel production, however, began in the early 1900's. Up to this time most needs had been supplied from roadside pits and from farmers' back yards. The period of low demand ended when the new cement age created an enormous demand for aggregates. Since this natural resource was not considered to be especially valuable during these early years, records of its production and use are so limited as to be practically non-existent.

Clay

The definition of clay, as the term is used in the Ohio annual reports, has never been too clear. Throughout the years, however, fire clay has been mentioned more than any other type of clay or shale. When, if ever, operators made a complete summary of their clay mining activities is not known, but most annual totals reflect more than fire clay production alone.

Reports for clay issued by the U.S. Bureau of Mines and the U.S. Geological Survey prior to 1943 have a very limited use. They do not include the very substantial amounts of captive tonnage used by Ohio's huge ceramic industry; open market tonnage only was reported. As a consequence these early production figures were completely unrealistic. The U.S. Census reported as many as 100 Ohio factories using Ohio clay in the manufacture of ceramics of one type or another as early as 1840. These factories reportedly employed some 200 men and managed a production valued at around $90,000. As the industry prospered captive tonnage became the major part of clay production in the state.

In spite of their deficiencies, then, annual reports of the State of Ohio continue to be the most reliable public source for such data during the early years of the industry and for later years through 1942. The current tabulation, therefore, makes use of the more comprehensive Ohio figures through the year 1942 and the U.S. Bureau of Mines data for 1943 through 1957.

Publications of the Ohio Geological Survey were found to be helpful in determining the estimated tonnages for the early years. They include: Vol. I, pt. 1, Vols. III, V, VII and Bull. 26. (See Bibliography.)

Gypsum

From annual reports, State of Ohio, Division of Mines and Division of Labor Statistics. In many cases production reported by the U.S. Geological Survey and the U.S. Bureau of Mines annual reports was preferred. Such years are indicated in the table. Estimates for 1821 - 1880 are based on data found in O.G.S. Vol. VI.

Salt

From annual reports of the U.S. Bureau of Mines and the U.S. Geological Survey. The year 1880 carries the U.S. Census figure for that year, 530,060 barrels. The years 1891 and 1892 are estimated in part, because production for those years was reported together with tonnage for other states. The 2,000,000 ton estimate for the period 1800-1875 was assembled through careful examination of statements made by Ohio geologists in early reports published by the Ohio Geological Survey. These quantitative statements, when available, were tabulated by year and county or area, and the summation approximating 2,000,000 tons resulted. Among the Ohio Geological Survey publications consulted were: First Annual Report, 1837; Second Annual Report, 1838; Report of Progress, 1869; Report of Progress, 1870; Vol. I, pt. 1; Vol. II, pt. 1; Vol. III; Vol. V; Vol. VI; Bulletins 8, 24, 27, 37; R.I.'s 3, 11. (See Bibliography.)

Iron

Iron ore production figures for the declining years of the industry in Ohio, 1884-1915, come from the annual reports of the U.S. Geological Survey. These figures, of course, must not be confused with those for the huge iron and steel manufacturing industry of this state. The mining of native ores began as early as 1804; mixing with ores from Missouri and the Lake Superior region also began at an early date. Our total for the period 1804-1875, 9,000,000 tons, has been assembled with native ores only in mind.

Production for the year 1880 is that reported in the U.S. Census for that year. The following census year data reported by Mr. R.P. Rothwell in his 'The Mineral Industry, Its Statistics, Technology and Trade, 1892' formed the basis for most of the estimated production in the very early years of the industry. These figures have been converted to 2,000-pound tons from their original 2,240-pound tons.

Year	Tons
1880	547,000
1870	625,703
1860	323,654
1850	157,483
1820-1850	1,800,000*
1810	10,000**

* Estimated for the 30-year period.
** An estimate of 100,000 tons was made for the entire country's production of which Ohio's share was about 10% or 10,000 tons.

These figures and those for many intervening years were further bolstered by references to the mining and smelting of Ohio ores found in the following publications of the Ohio Geological Survey: First Annual Report, 1837; Second Annual Report, 1838; Report of Progress, 1869; Report of Progress, 1870; Vol. II, Pt. 1; Vol. V; Bulletins 41 and 45. (See Bibliography.)

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